DRAFT

TMDL for Fecal Coliform Bacteria for Selected Subsegments in the Sabine River Basin, Louisiana
(110202, 110401, 110402, 110501, and 110504)

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EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies. A TMDL establishes the amount of a pollutant that a waterbody can assimilate without exceeding its water quality standard for that pollutant. TMDLs provide the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody and may include a future growth (FG) component. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS + FG$$

The study area for this TMDL includes five subsegments in the Sabine River Basin. The Sabine River originates in northeast Texas and flows southeast into the northern section of Toledo Bend Reservoir along the southern half of the Louisiana-Texas border. The river continues from the southern section of the reservoir and flows south to the Gulf of Mexico. Forest is the dominant land use in all the listed subsegment watersheds. The remaining areas are mostly wetlands, pasture/hay, and barren land. There are small pockets of urban land in all but one subsegment watershed.

The Louisiana Department of Environmental Quality (LDEQ) has included five subsegments in the Sabine River Basin on the state's 2004 section 303(d) list for fecal coliform bacteria impairments (Table ES-1). The impaired designated uses for the five subsegments are primary contact recreation and fish and wildlife propagation.

Table ES-1. Section 303(d) listing for subsegments included in this report

Subseg. number	Subsegment name	Impaired use[a]	Causes of impairment	Suspected sources of impairment
			Fecal coliform bacteria	
110202	Pearl Creek	PCR	X	Managed pasture grazing
110401	Bayou Toro	PCR	X	Managed pasture grazing
110402	Bayou Toro	PCR	X	Managed pasture grazing
110501	West Anacoco Creek	PCR, FWP	X	Managed pasture grazing
110504	Bayou Anacoco	PCR	X	Wildlife other than waterfowl

[a] PCR = primary contact recreation; FWP = fish and wildlife propagation
Source: LDEQ 2005a.

The numeric water quality criteria that apply to the impaired subsegments in the Sabine River Basin and that were used to calculate the total allowable loads are the primary contact water quality criteria for fecal coliform bacteria. The primary contact recreation criteria are applicable from May 1 through October 31 (LDEQ 2005b). During the remainder of the year (November 1 through April 30), secondary contact criteria are applicable. For primary contact recreation, no more than 25 percent of the total samples may exceed a fecal coliform bacteria density of 400 colonies/100 mL. The samples should be collected on a monthly or near-monthly basis. Secondary contact criteria are similar to primary contact criteria in that no more than 25 percent of the total samples collected on a monthly or near-monthly basis may exceed a fecal coliform bacteria density of 2,000 colonies/100 mL.

The TMDLs for fecal coliform bacteria were developed using load duration curve methodology. This method illustrates allowable loading at a wide range of streamflow conditions. The steps for applying this methodology were (1) developing a flow duration curve; (2) converting the flow duration curve to load duration curves; (3) plotting observed loads with load duration curves; (4) calculating the TMDL, MOS, FG, WLA, and LA; and (5) calculating percent reductions. The seasonal fecal coliform bacteria TMDLs were developed on the basis of analyses of the applicable water quality criteria (i.e., calculating allowable loads and percent reductions for both summer and winter).

In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis for establishing water quality-based controls. WLAs were given to permitted point source discharges. The LAs include background loadings and human-induced nonpoint sources. An explicit MOS of 10 percent and an FG component of 10 percent were included. None of the subsegments requires fecal coliform bacteria reductions in the winter months, and the summer month reductions range from 28 to 72 percent. A summary of the TMDLs for the subsegments addressed in this report is presented in Table ES-2.

Table ES-2. Summary of fecal coliform bacteria TMDLs, MOS, WLAs, FGs, and LAs for Sabine River Basin

Subsegment	Station	Season	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				1×10^9 colonies/day				
110202	1156	Summer	72	2.48	0.25	0.25	1.15	0.83
110202	1156	Winter	0	36.05	3.61	3.61	1.15	27.69
110401	1160	Summer	67	83.23	8.32	8.32	0.95	65.64
110401	1160	Winter	0	1,209.58	120.96	120.96	0.95	966.72
110402	1161	Summer	55	33.59	3.36	3.36	0.00	26.87
110402	1161	Winter	0	488.08	48.81	48.81	0.00	390.46
110501	1162	Summer	60	35.03	3.50	3.50	0.39	27.64
110501	1162	Winter	0	448.66	44.87	44.87	0.39	358.54
110504	1165	Summer	28	2.78	0.28	0.28	0.13	2.10
110504	1165	Winter	0	43.24	4.32	4.32	0.13	34.47

Hurricane Katrina made landfall on Monday, August 29, 2005, as a Category 4 hurricane. The storm brought heavy winds and rain to southeast Louisiana, breaching several levees and flooding up to 80 percent of New Orleans and large areas of coastal Louisiana. Much of the area that was flooded during Hurricane Katrina was flooded again by the storm surge from Hurricane Rita. Both Hurricanes Katrina and Rita have caused a significant amount of change in sedimentation and water quality in southern Louisiana. Many wastewater treatment facilities were temporarily or permanently damaged. Some wastewater treatment facilities will be rebuilt while others will be relocated. The hurricanes expedited the loss of coastal land and modified the hydrology of some of the coastal waterbodies. Several federal and state agencies including the EPA and LDEQ are engaged in collecting environmental data and assessing the recovery of the Gulf of Mexico waters. The proposed TMDLs in this report were developed on the basis of pre-hurricane conditions. Therefore, post-hurricane conditions and other factors could delay the implementation of these proposed TMDLs, render some proposed TMDLs obsolete, or could require modifications of the TMDLs.

Much of coastal Louisiana was built by the process of delta formation through flooding and deposition of sediments by the rise and fall of the Mississippi River. According to EPA's present knowledge, extensive areas of wetlands and coastal marshes are affected by a high rate of subsidence and degradation, primarily due to a lack of historical sediment and nutrients entering the wetlands. Subsidence is a natural process, but the building of levee systems has restricted the Mississippi River's course and, therefore, is preventing the natural cycle of the river and the natural process of delta formation. According to EPA, a large portion of the state's coastal wetlands have undergone and continue to undergo severe deprivation of sediments and nutrients that has led to the breakup of the natural system. In addition, EPA believes that many of Louisiana's wetlands have become isolated from the riverine sources that created them and are becoming stagnant and starved for nutrients and organic and inorganic sediments. Note that restoring these eroding wetlands involves supplying nutrients to these areas through managed Mississippi River diversions.

According to EPA's understanding, if any future diversion from the Mississippi River or other tributaries will increase flow, the nonpoint source load allocation and TMDLs will also be increased proportionately. From EPA's current understanding, the diversion projects are supported by both state and federal agencies, including EPA and the U.S. Army Corps of Engineers (USACE). The diversions are managed by the USACE and the state, and the projects include post-diversion monitoring to determine effectiveness of the project and to monitor water quality conditions.

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1 INTRODUCTION

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not supporting their designated uses, even if pollutant sources have implemented technology-based controls. A TMDL establishes the maximum allowable load (mass per unit time) of a pollutant that a waterbody is able to assimilate and still support its designated uses. The maximum allowable load is determined on the basis of the relationship between pollutant sources and in-stream water quality. A TMDL provides the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

Monitoring data collected by the Louisiana Department of Environmental Quality (LDEQ) indicate that observed water quality data sometimes exceed the fecal coliform bacteria water quality criteria for five subsegments in the Sabine River Basin. The impaired uses for the five subsegments include primary contact recreation and fish and wildlife propagation. Table 1-1 presents information from the Louisiana's 2004 section 303(d) list for the five subsegments.

Table 1-1. Subsegments and impairments addressed in this report

Subseg. number	Subsegment name	Impaired use[a]	Causes of impairment	Suspected sources of impairment
			Fecal coliform bacteria	
110202	Pearl Creek	PCR	X	Managed pasture grazing
110401	Bayou Toro	PCR	X	Managed pasture grazing
110402	Bayou Toro	PCR	X	Managed pasture grazing
110501	West Anacoco Creek	PCR, FWP	X	Managed pasture grazing
110504	Bayou Anacoco	PCR	X	Wildlife other than waterfowl

[a] PCR = primary contact recreation; FWP = fish and wildlife propagation
Source: LDEQ 2005a.

2 BACKGROUND INFORMATION

2.1 General Description

The five listed subsegments are in Sabine and Vernon Counties in western Louisiana. The subsegments are in U.S. Geological Survey (USGS) hydrologic unit code (HUC) 12010005. All the subsegments eventually drain to the Sabine River, which flows along the southern half of the Louisiana and Texas border. The Sabine River originates in northeast Texas and flows southeast into the northern section of Toledo Bend Reservoir. The river continues from the southern section of the reservoir and flows south to the Gulf of Mexico.

The area of interest for this TMDL consists of the entire length of Bayou Toro (subsegments 110401 and 110402), which flows to the Sabine River directly below Toledo Bend Reservoir; West Anacoco Creek (subsegment 110501), which flows into Lake Vernon; the portion of Bayou Anacoco (subsegment 110504) between Lake Vernon and Lake Anacoco; and Pearl Creek (subsegment 110202), which flows directly into the Sabine River between Bayou Toro and Bayou Anacoco (Figure 2-1). Table 2-1 lists the parishes in which the subsegments are located and the approximate drainage area of each subsegment.

Table 2-1. Parish and drainage area for each listed subsegment in the Sabine River Basin

Segment number	Segment name	Parish	Drainage area (acres)
110202	Pearl Creek	Vernon	643.6
110401	Bayou Toro	Sabine	8,753.8
110402	Bayou Toro	Sabine, Vernon	3,534.7
110501	West Anacoco Creek	Sabine, Vernon	2,653.1
110504	Bayou Anacoco	Vernon	253.4

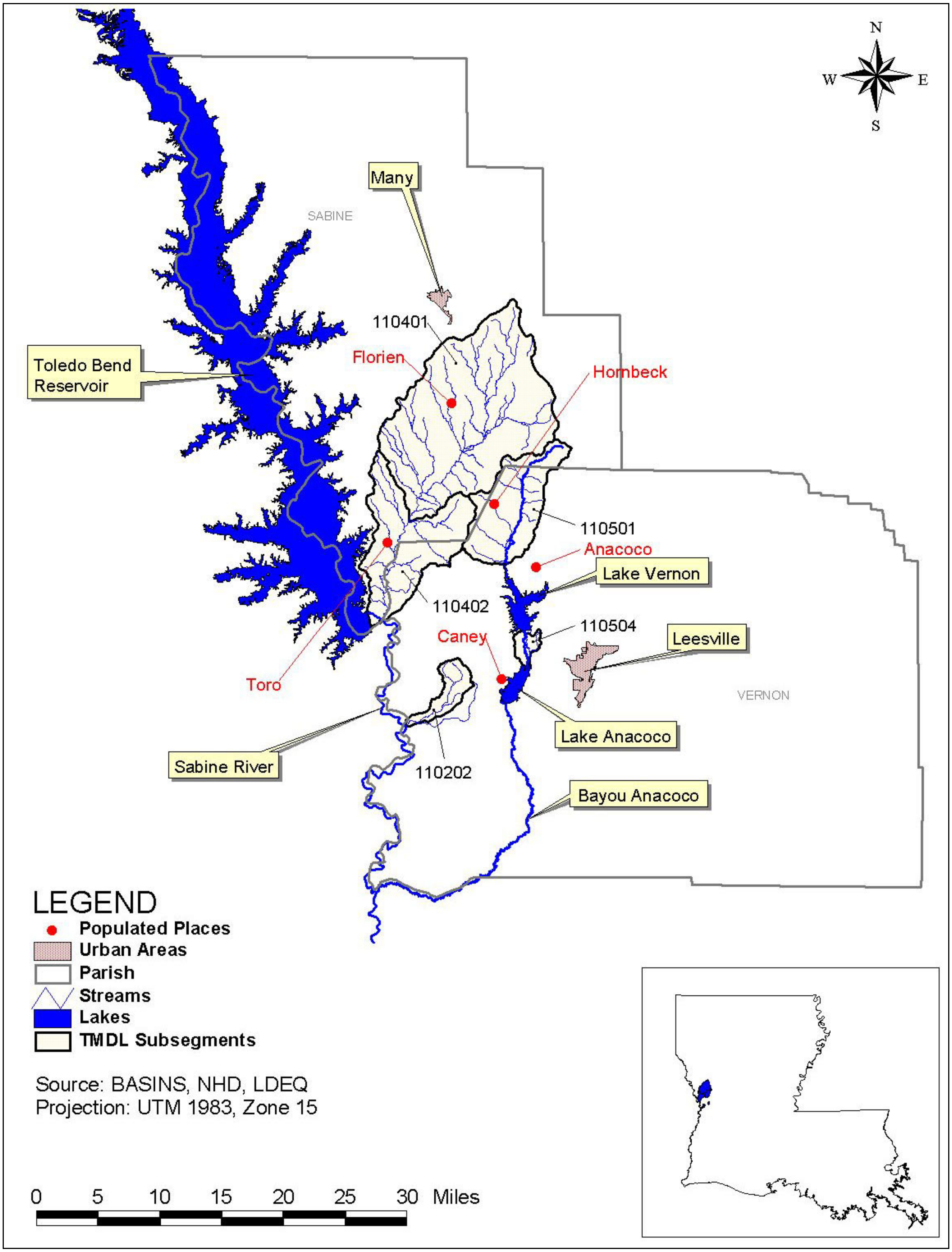

Figure 2-1. Location of Sabine River Basin subsegments.

2.2 Land Use

Land use data were obtained from the USGS National Land Cover Dataset (NLCD). The NLCD data are based on satellite imagery from the early 1990s. Forest is the dominant land use in all the listed subsegment watersheds in the Sabine River Basin (Table 2-2 and Figure 2-2). Most of the remaining areas are composed of wetlands, pasture/hay, and barren land. There are small pockets of urban area in the watersheds of all the listed subsegments, except for subsegment 110402 (Bayou Toro).

Table 2-2. Land use percentages for each listed subsegment in the Sabine River Basin

Land use	Percent coverage by subsegment number				
	110202	110401	110402	110501	110504
Water	0.0	0.4	0.5	0.3	1.0
Urban	0.6	0.8	0.0	1.4	2.1
Barren	14.0	4.3	3.5	3.6	3.0
Forest	70.0	83.4	90.9	80.2	60.9
Grasslands/herbaceous	0.0	0.0	0.0	0.0	0.0
Pasture/hay	7.8	6.0	0.9	8.5	6.5
Row crops	0.7	1.4	0.3	2.2	1.3
Small grains	0.0	0.0	0.0	0.0	0.0
Urban/recreational grasses	0.0	0.0	0.1	0.1	0.7
Wetlands	6.8	3.6	3.7	3.9	24.4
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

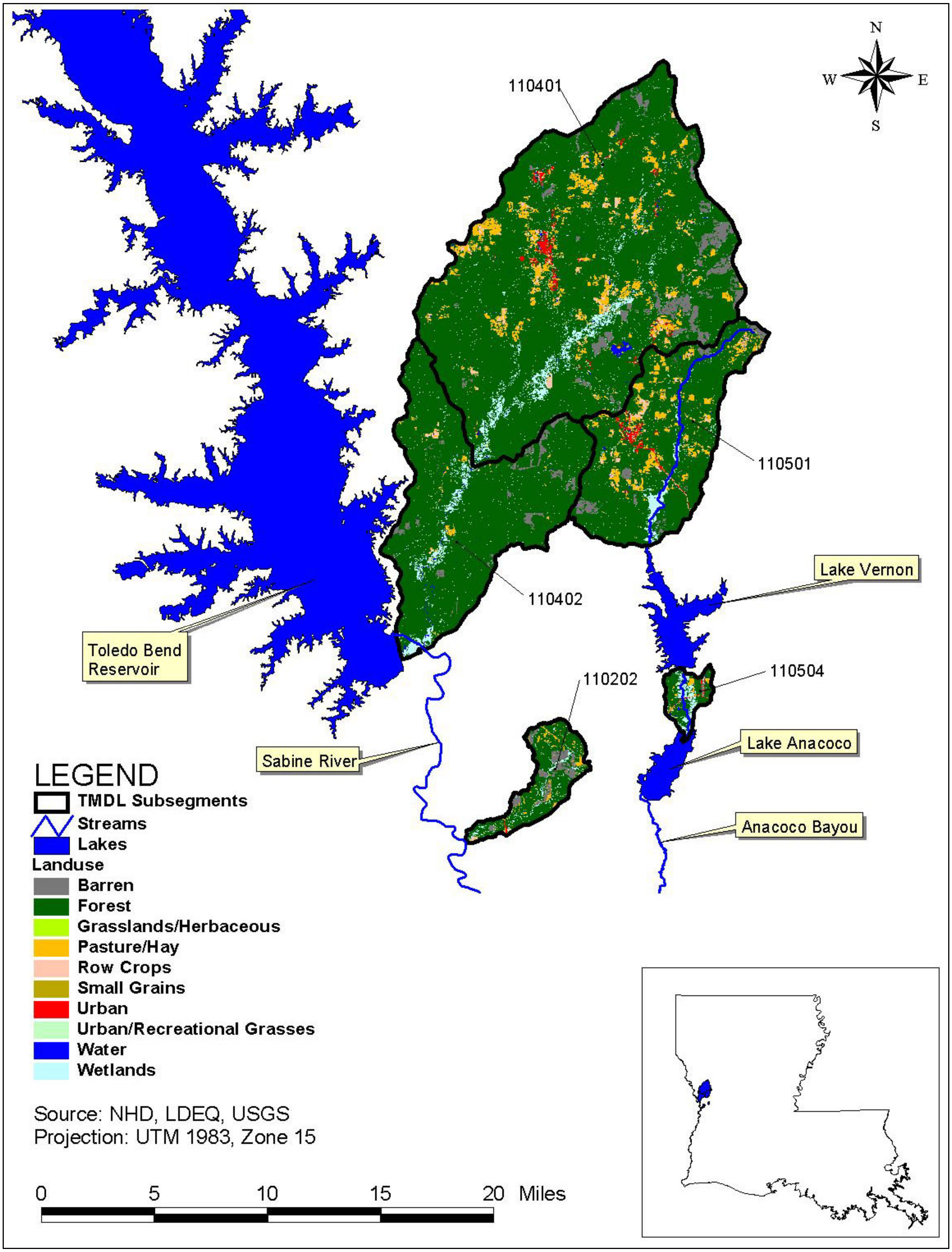

Figure 2-2. Land use in the Sabine River Basin subsegments.

2.3 Flow Characteristics

There are only two active USGS flow monitoring gages in the TMDL area of interest; therefore, flow data are not available for all the listed subsegments in the Sabine River Basin. Table 2-3 presents information for the two flow gages.

Table 2-3. USGS flow gage information for the Sabine River Basin

Station number	Station name	Period of record	Drainage area (square miles)
08028000	Bayou Anacoco near Rosepine, LA	10/1/1951–9/30/2002	365
08025500	Bayou Toro near Toro, LA	10/1/1955–9/30/2002	148

Station 08028000 is approximately 15.2 miles downstream of Anacoco Lake on Bayou Anacoco. Station 0802550 is on Bayou Toro at the boundary between the upper (segment 110401) and lower (segment 110402) portions of Bayou Toro. The locations of the two USGS gages are shown in Figure 2-3.

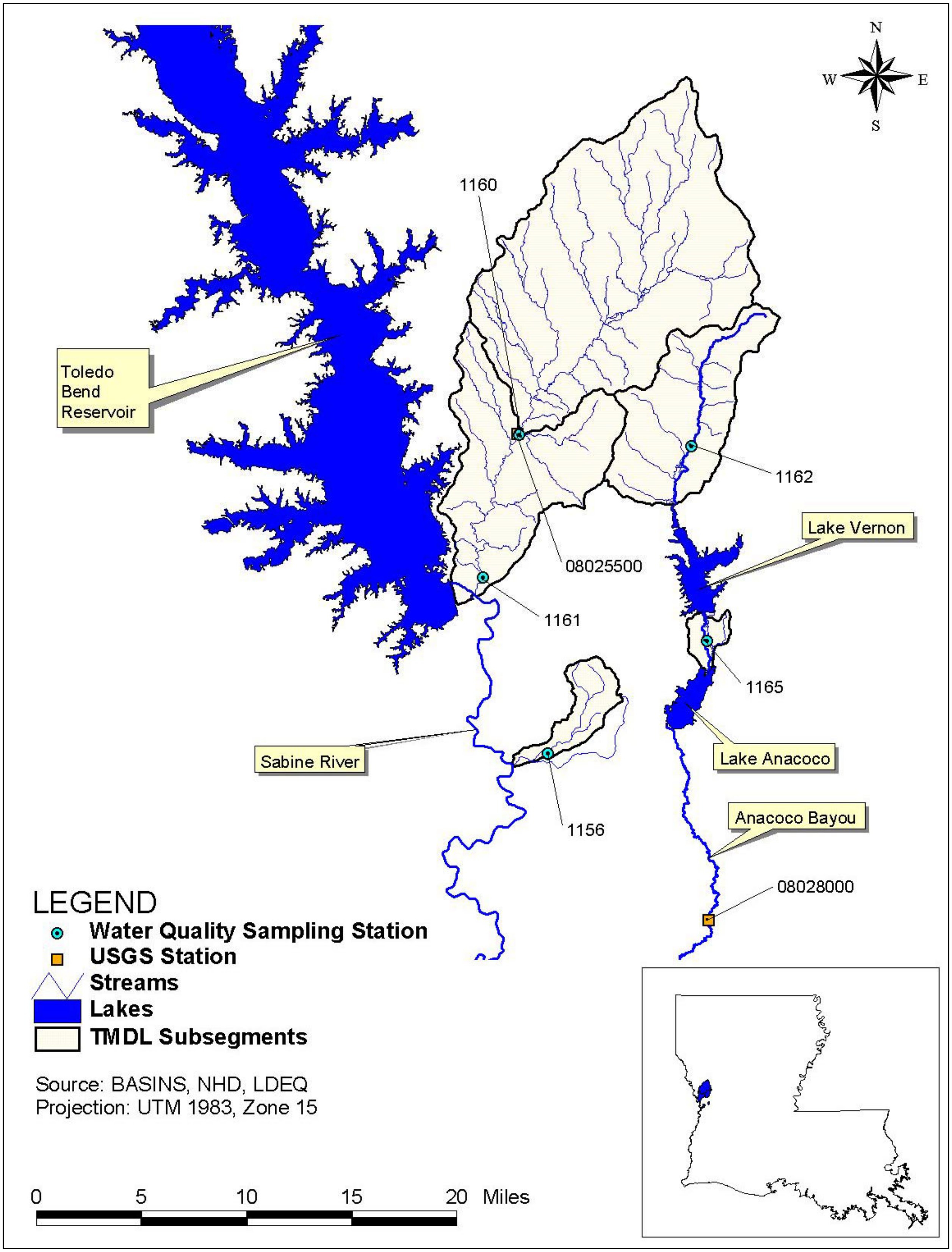

Figure 2-3. Location of the USGS flow gages and water quality stations in the Sabine River Basin.

The seasonal distribution of flow at each of the flow gaging stations is shown in Figures 2-4 and 2-5 for stations 08028000 and 08025500, respectively. Low flow occurs in the summer and early fall, and high flow tends to occur in late winter and early spring.

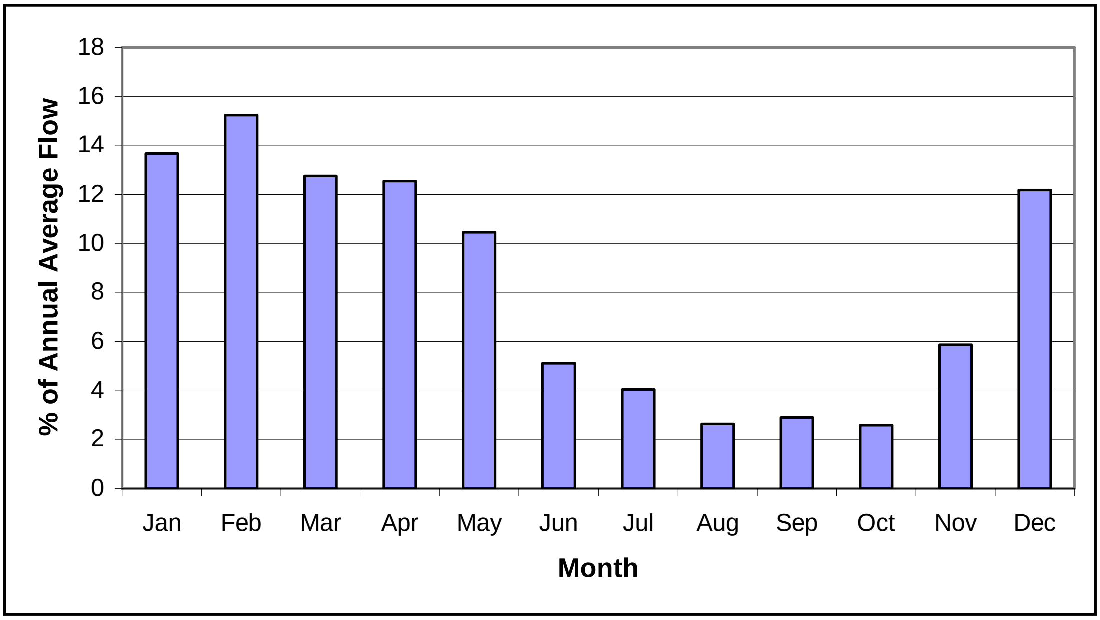

Figure 2-4. Seasonal distribution of flow for Bayou Toro near Toro, Louisiana (USGS 08028000) (1952 through 2001).

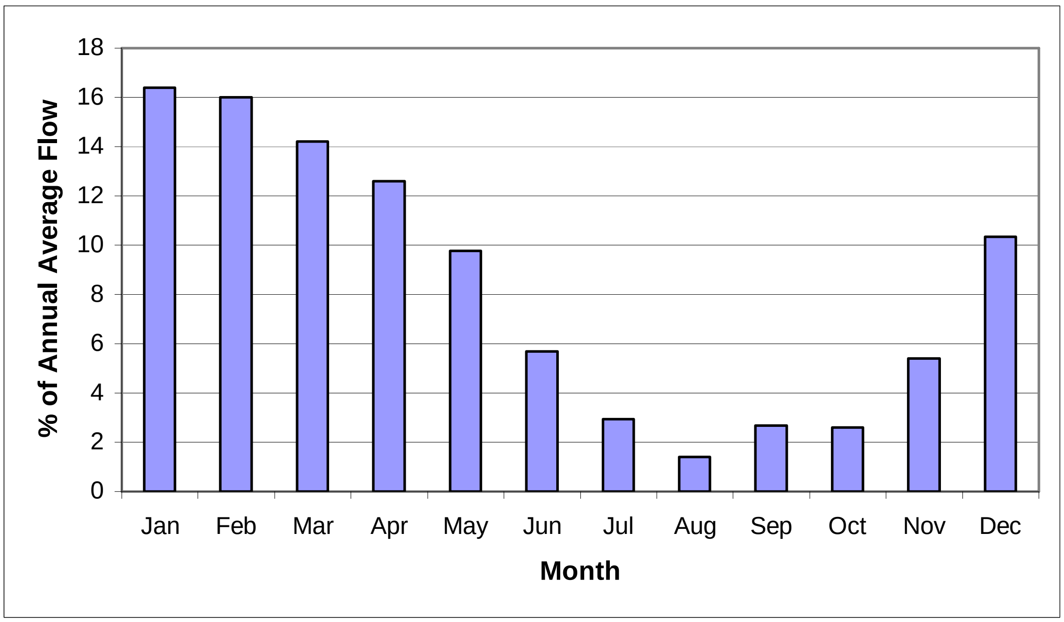

Figure 2-5. Seasonal distribution of flow for Bayou Anacoco near Rosepine, Louisiana (USGS 08025500) (1956 through 2001).

2.4 Designated Uses and Water Quality Criteria

The state of Louisiana's 2004 section 303(d) list indicates that the five listed subsegments, all assigned a designated use of primary contact recreation, are not meeting applicable water quality standards due to impairments suspected to be the result of managed pasture grazing. Managed pasture grazing involves livestock production on managed grasslands, which are also usually used for hay production. One segment (110501) has also been assigned the fish and wildlife propagation designated use, though, water quality standards indicate the primary contact recreation criteria to be the appropriate applicable criteria. Primary contact recreation involves any recreational or other water contact involving full-body exposure to water and considerable probability of the ingestion of water. Examples include swimming and water skiing. Secondary contact recreation involves activities such as fishing, wading, or boating where water contact is accidental or incidental and there is a minimal chance of ingesting appreciable amounts of water.

Primary contact water quality criteria for fecal coliform bacteria are applicable from May 1 through October 31 (LDEQ 2005b). During the remainder of the year (November 1 through April 30), secondary contact criteria are applicable. For primary contact recreation, no more than 25 percent of the total samples may exceed a fecal coliform bacteria density of 400 colonies/100 mL. The samples should be collected on a monthly or near-monthly basis. Secondary contact criteria are similar to primary contact criteria in that no more than 25 percent of the total samples collected on a monthly or near-monthly basis may exceed a fecal coliform bacteria density of 2,000 colonies/100 mL.

The numeric criteria were used in conjunction with the assessment methodology presented in LDEQ's 305(b) report (LDEQ 2002). LDEQ's assessment methodology specifies that primary contact recreation and secondary contact recreation uses are to be fully supported with no more than 25 percent of the values exceeding the fecal coliform bacteria criteria.

The Louisiana water quality standards also include an antidegradation policy (*Louisiana Administrative Code* [LAC] Title 33, Part IX, Section 1109.A), which states that state waters exhibiting high water quality should be maintained at that high level of water quality. If this is not possible, water quality of a level that supports the designated uses of the waterbody should be maintained. The designated uses of a waterbody may be changed to allow a lower level of water quality only through a use attainability study.

2.5 Point Sources

Information on point source discharges to the listed subsegments was obtained from LDEQ files. LDEQ stores permit information using internal databases. Data were pulled from these databases and analyzed for this TMDL. The search yielded 12 point source discharges (Table 2-4). Point source contributions from municipal wastewater systems do not account for a large portion of the current fecal coliform bacteria loading to the listed subsegments. There are no municipal separate storm sewer system (MS4) permits in the five subsegment watersheds addressed in this TMDL report.

Table 2-4. Point source discharge information for the Sabine River Basin

Permit number	Facility name	Location	Outfall	Flow (gpd)[a]	Receiving water	Monthly average permit limit (colonies/ 100 mL)	Weekly average permit limit (colonies/ 100 mL)
Subsegment 110202							
LA0055867	Merryville, town of —WWTP	LA Hwy 389	001	143,000	Hoosier Creek-Old River-Sabine River	200	400
LAG530498	Burr Ferry Main K3569	Burr Ferry, LA Hwy 8	001	< 100	Forker Creek-Sabine River	200	400
LAG540001	Starks Truck Stop and Starks Silver Dollar	Starks 4344A Hwy 12	001	350 (estimated avg)	local drainage to Sabine River	200	400
LAG540700	Starks Place Apartments	Starks, 4738 Evangeline Rd	001	8,600 (estimated avg)	Old River	200	400
Subsegment 110401							
LA0093939	Fisher/Florein WWTP	Florein, Jack Salter Rd or 2734 Ebeneezer Rd	001 – sant. WW	125,000	Midkiff Creek-Bayou Toro	200	400
Subsegment 110501							
LAG530060	New Llano Branch Office	Leesville,12542 Lake Charles Hwy (171)	001	1,185 (max)	Ditch-Bayou Castor-Bayou Anacoco	200	400
LAG560106	Hornbeck, city of —WWTP	105 Brush Creek Rd		50,000[b]		200[b]	400[b]
Subsegment 110504							
LAG530097	Brookhaven Apartments	144 Brookhaven Rd, Leesville, 71446	001	4,200 (estimated max)	Castor Creek to Anacoco Creek	200	400
LAG530162	Helen’s Barber Pole	Leesville, 273 Entrance Rd	001	619 (sampled avg)	Bayou Zourie-Castor-Anacoco	200	400
LAG530254	Hunan Chinese Restaurant	Leesville 3094 Hwy 171 S	001	1,000 (treatment plant size)	Bayou Castor-Bayou Anacoco	200	400
LAG530475	Ellerston Property	New Llano 1010 Savage Fork Rd (LA1211)	001	3,600 (avg)	Bayou Castor	200	400
LAG540288	Elimelech Mobile Home Park	Leesville, 3852 VFW Rd, 0.5 mile W of 1211	001	7,800 (estimated avg)	Mill Creek	200	400

[a] gpd = gallons per day
[b] This flow is standard for general permits with this number. Permit limits are general permit limits for monthly average and daily maximum in summer.

2.6 Nonpoint Sources

The state of Louisiana’s section 303(d) list identifies managed pasture grazing as the suspected cause of the fecal coliform bacteria impairment in the subsegments of the Sabine River Basin. The predominant land use in the impaired subsegment watersheds is forest. The watersheds also contain pasture, cropland, wetlands, and urban areas. The percentage of pasture in the watersheds ranges from just under one percent to 8.5 percent. Additional potential sources of fecal coliform bacteria, not included on the section 303(d) list, are wildlife, failing septic systems, and deteriorating sewer systems.

3 CHARACTERIZATION OF EXISTING WATER QUALITY

3.1 Comparison of Observed Data to Criteria

Fecal coliform bacteria monitoring data for each listed subsegment were obtained from LDEQ (Table 3-1 and Figure 3-1). Each station had 12 samples collected in 2002, except station 1162, which had 11 samples. The samples collected at all stations from November through April did not have any exceedances of the water quality criterion of 2,000 colonies/100 mL. Each sampling location had exceedances of the primary contact criterion of 400 colonies/100 mL during the summer months. The percentage of exceedances ranged from 33 percent (at stations 1160, 1161, and 1165) to 60 percent (at station 1162). Stations 1156 and 1162 had the most samples above the criterion, and station 1160 had the largest single sample concentration.

Table 3-1. Summary of fecal coliform bacteria data in the Sabine River Basin

Station number	Station name	Period of record	No. of obs.	Min. MPN/ 100 mL	Max. MPN/ 100 mL	Median MPN/ 100 mL	Number of obs. above criteria[a]	Percent of obs. above criteria[a]
May 1 through October 31								
1156	Pearl Creek northwest of Burr Ferry, LA	2002	6	2	5,000	305	3	50
1160	Bayou Toro northeast of Toro, LA	2002	6	23	16,000	155	2	33
1161	Bayou Toro at Louisiana Hwy 392, LA	2002	6	30	2,200	145	2	33
1162	West Anacoco Creek at US Hwy 171, LA	2002	5	130	1,100	800	3	60
1165	Bayou Anacoco at Standard, LA	2002	6	70	500	205	2	33
January 1 through April 30 and November 1 through December 31								
1156	Pearl Creek northwest of Burr Ferry, LA	2002	6	30	1,600	135	0	0
1160	Bayou Toro northeast of Toro, LA	2002	6	70	1,700	360	0	0
1161	Bayou Toro at Louisiana Hwy 392, LA	2002	6	23	900	100	0	0
1162	West Anacoco Creek at US Hwy 171, LA	2002	6	70	220	95	0	0
1165	Bayou Anacoco at Standard, LA	2002	6	2	110	26	0	0

[a] Fecal coliform bacteria criteria for primary contact recreation: No more than 25 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform bacteria density of 400 colonies/100 mL from May 1 through October 31. During the nonrecreational period of November 1 through April 30, the criteria for secondary contact recreation shall apply (no more than 25 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform bacteria density of 2,000 colonies/100 mL).

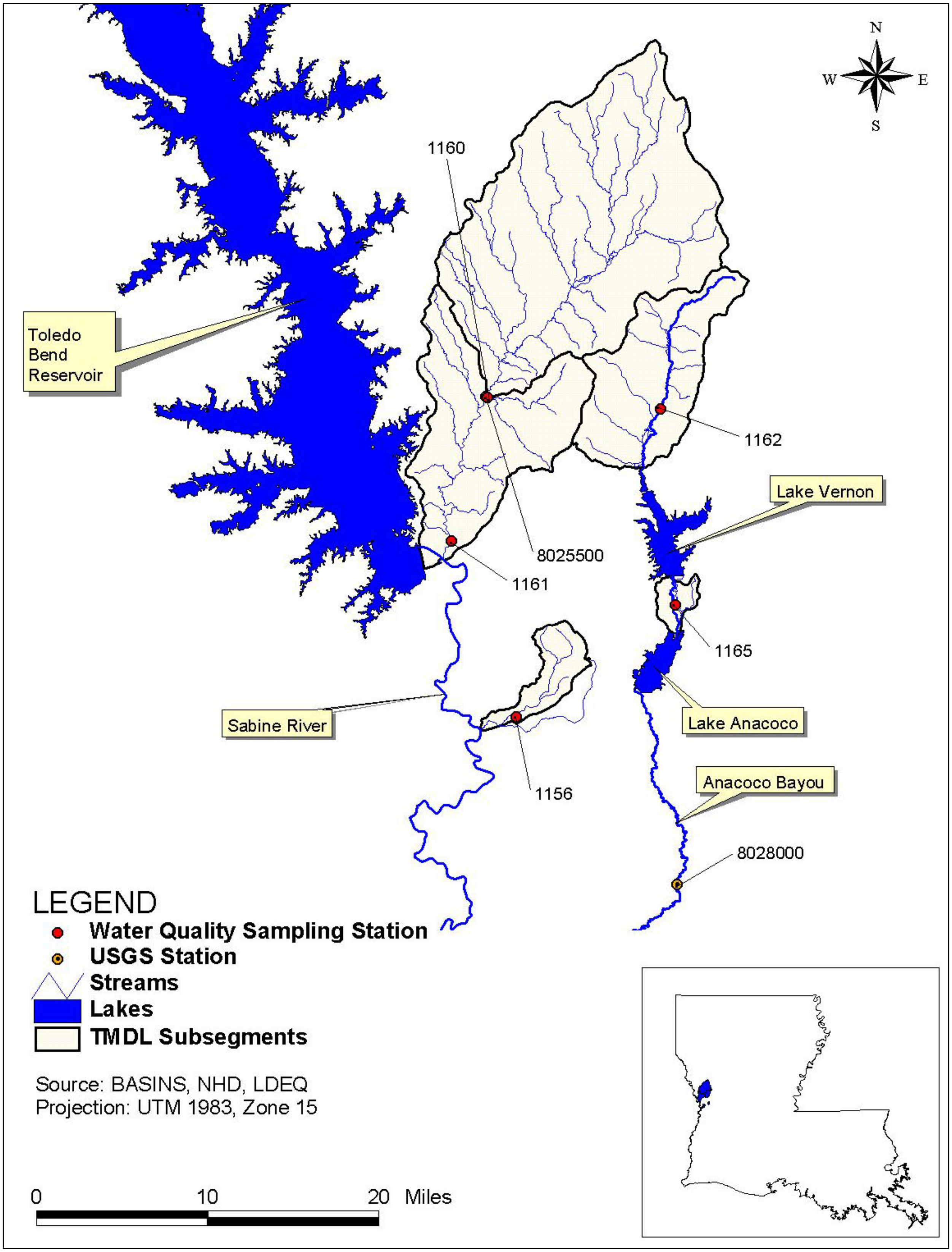

Figure 3-1. Location of water quality stations and USGS flow gages in the Sabine River Basin.

3.2 Trends and Patterns in Observed Data

Because of the limited number of samples, no distinct trends or patterns were found in the reported monitoring results. The highest fecal coliform bacteria concentrations were observed during the summer months and usually during low-flow conditions. Limited sample collection during high-flow periods limit the comparability of low-flow and high-flow monitoring results. Higher concentrations would be expected at high-flow conditions after a precipitation event when the fecal coliform bacteria have the potential to be washed off the pasture into the waterbody. Appendix A contains the sampling results along with plots of sampling results over time and versus flow.

4 TMDL DEVELOPMENT

A TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis for establishing water quality-based controls.

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. This TMDL also includes a future growth (FG) component to account for loadings from the continued growth in the TMDL area. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS + FG$$

For some pollutants, TMDLs are expressed as a mass loading (e.g., kilograms per day). For bacteria, however, TMDLs can be expressed in terms of organism counts per day, in accordance with 40 CFR 130.2(l).

4.1 TMDL Analytical Approach

The methodology used to determine the TMDL for each impaired subsegment is the load duration curve. Because loading capacity varies as a function of the flow present in the stream, these TMDLs represent a continuum of desired loads over all flow conditions, rather than a fixed single value. The basic elements of this procedure are documented on the Kansas Department of Health and Environment Web site (KDHE 2003). This method was used to illustrate allowable loading for a wide range of flows. The steps for how this methodology was applied for the TMDLs in this report can be summarized as follows:

1. Develop a flow duration curve.
2. Convert the flow duration curve to load duration curves for each impairment.
3. Plot observed loads with load duration curves.
4. Calculate TMDL, MOS, FG, WLA, and LA (see also Section 4.2).
5. Calculate percent reductions required to meet assessment criteria.

Flow Duration Curve

A flow per unit area duration curve was developed for each USGS gage for the TMDLs. Daily streamflow measurements from USGS gages for each data set were sorted in increasing order, and the percentile ranking of each flow was calculated. For fecal coliform bacteria, the daily streamflow measurements from USGS gages were separated into summer (May through October) and winter (November through April) data sets to accommodate the state’s seasonal criteria. The load duration methodology requires that the same flow period be used for both developing the flow duration and calculating observed loads from sampling data. For each season, the flows per unit area were then plotted against the corresponding percent flow that exceeds a specific flow to create the flow duration curves.

Figure 4-1 is an example of a flow duration curve. The plot shows the flow per unit area (e.g., cubic feet per second per square mile) on the Y-axis. The X-axis shows the percentage of days on which the plotted flow is exceeded. Points at the lower end of the plot (0 through 10 percent) represent high-flow conditions where only 0 through 10 percent of the flow exceeds the plotted point. Conversely, points on the high end of the plot (90 to 100 percent) represent low-flow conditions.

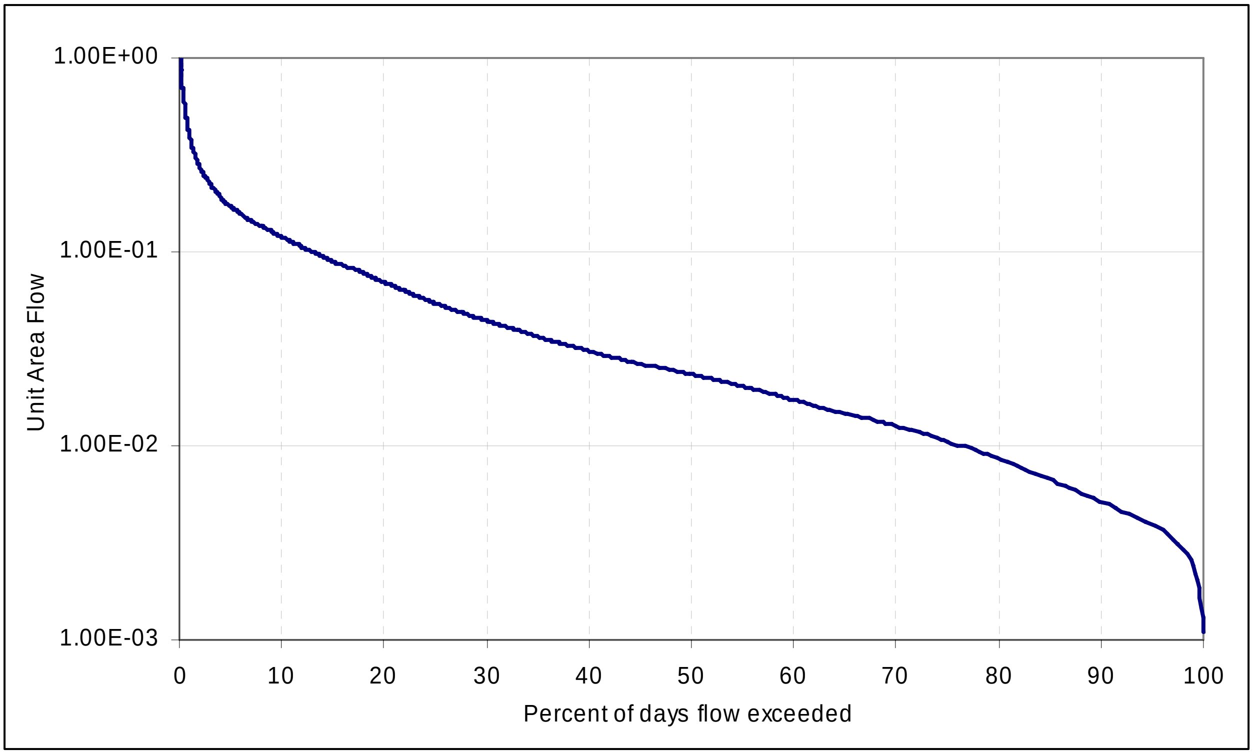

Figure 4-1. Example of Load Duration Curve.

Because there are only two active USGS flow monitoring gages in the TMDL area of interest, flow data are not available for all the listed subsegments in the Sabine River Basin. Many USGS gages in the area were not used because their period of record did not intersect the period of record for the water quality data. Other USGS gages were not used because they were not representative of the subsegments of interest. The two gages were assigned to each subsegment in the Sabine River Basin to represent flow. Table 4-1 presents each USGS gage, the period of record used in the TMDL analysis, and the subsegments it represents.

Table 4-1. USGS flow gages and represented subsegments for the Sabine River Basin

Station number	Station name	Period of record used in TMDL development	Subsegments represented
08025500	Bayou Toro near Toro, LA	1/1/1980–9/30/2002	110202, 110501, 110504
08028000	Bayou Anacoco near Rosepine, LA	1/1/1980–9/30/2002	110401, 110402

Load Duration Curve

For each season, the flows per unit area from the flow duration curves were multiplied by the appropriate fecal coliform bacteria target concentration (Section 2.4) to compute an allowable load per unit area duration curve. Each load duration curve is a plot of mass per day per subsegment watershed area versus the percent flow exceedance from the flow duration curves. Because the load duration curves were expressed by unit of drainage area, each curve was assumed applicable at all sampling stations and for all stream reaches in that subsegment.

The load duration curve is beneficial when analyzing monitoring data because it presents corresponding flow information and monitoring results plotted as a load. This approach allows the monitoring data to be placed in relation to their place in the flow continuum. Assumptions of the probable source or sources of the impairment can then be made from the plotted data. The load duration curve shows the calculation of the TMDL at any flow rather than at a single critical flow. The official TMDL number is reported as a single number, but the curve is provided to demonstrate the value of the acceptable load at any flow. This will allow analysis of load cases in the future for different flow regimes. Appendix B contains the load duration curve calculations.

Observed Loads

For each sampling station and season, observed loads were calculated by multiplying the observed concentration of the parameter of concern by the flow per unit area on the sampling day. These observed loads were then plotted versus the percent flow exceedance of the flow per unit area on the sampling day and placed on the same plot as the load duration curve. Reductions were applied to the observed loads until the water quality criteria and allowable percent exceedance were met to obtain an overall percent reduction for each subsegment. These plots are shown in the appendices of this report as follows:

Appendix C: Load Duration Curve and Plots for Fecal Coliform Bacteria: Summer
Appendix D: Load Duration Curve and Plots for Fecal Coliform Bacteria: Winter

These plots provide visual comparisons between observed and allowable loads under different flow conditions. Observed loads that are plotted above the load duration curve represent conditions where observed water quality concentrations exceed the target concentrations. Observed loads plotted below the load duration curve represent conditions where observed water quality concentrations were less than target concentrations (i.e., not exceeding water quality standards).

4.2 TMDL, WLA, and LA

Each TMDL was calculated as the area under the load duration curve. Because the load duration curves were expressed in mass per unit drainage area, the area under the curve was multiplied by the drainage area for each subsegment. Table 4-2 presents the TMDLs and allocations for the subsegments in this report.

Table 4-2. Summary of fecal coliform bacteria TMDLs, MOS, FG, WLAs, and LAs for Sabine River Basin

Subsegment	Station	Season	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				1×10^9 colonies/day				
110202	1156	Summer	72	2.48	0.25	0.25	1.15	0.83
110202	1156	Winter	0	36.05	3.61	3.61	1.15	27.69
110401	1160	Summer	67	83.23	8.32	8.32	0.95	65.64
110401	1160	Winter	0	1,209.58	120.96	120.96	0.95	966.72
110402	1161	Summer	55	33.59	3.36	3.36	0.00	26.87
110402	1161	Winter	0	488.08	48.81	48.81	0.00	390.46
110501	1162	Summer	60	35.03	3.50	3.50	0.39	27.64
110501	1162	Winter	0	448.66	44.87	44.87	0.39	358.54
110504	1165	Summer	28	2.78	0.28	0.28	0.13	2.10
110504	1165	Winter	0	43.24	4.32	4.32	0.13	34.47

Both section 303(d) of the Clean Water Act and the regulations at 40 CFR 130.7 require that TMDLs include an MOS to account for uncertainty in available data or in the actual effect that controls will have on the loading reductions and receiving water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly using conservative assumptions in establishing the TMDL. For a more detailed discussion of the MOS, see Section 4.4. In addition to the MOS, an FG component was added for an additional MOS to account specifically for future growth in the TMDL area (see Section 4.5).

Hurricane Katrina made landfall on Monday, August 29, 2005, as a Category 4 hurricane. The storm brought heavy winds and rain to southeast Louisiana, breaching several levees and flooding up to 80 percent of New Orleans and large areas of coastal Louisiana. Much of the area that was flooded during Hurricane Katrina was flooded again by the storm surge from Hurricane Rita. Both Hurricanes Katrina and Rita have caused a significant amount of change in sedimentation and water quality in southern Louisiana. Many wastewater treatment facilities were temporarily or permanently damaged. Some wastewater treatment facilities will be rebuilt while others will be relocated. The hurricanes expedited the loss of coastal land and modified the hydrology of some of the coastal waterbodies. Several federal and state agencies including the EPA and LDEQ are engaged in collecting environmental data and assessing the recovery of the Gulf of Mexico waters. The proposed TMDLs in this report were developed on the basis of pre-hurricane conditions. Therefore, post-hurricane conditions and other factors could delay the implementation of these proposed TMDLs, render some proposed TMDLs obsolete, or could require modifications of the TMDLs.

Much of coastal Louisiana was built by the process of delta formation through flooding and deposition of sediments by the rise and fall of the Mississippi River. According to EPA’s present knowledge, extensive areas of wetlands and coastal marshes are affected by a high rate of subsidence and degradation, primarily due to a lack of historical sediment and nutrients entering the wetlands. Subsidence is a natural process, but the building of levee systems has restricted the

Mississippi River's course and, therefore, is preventing the natural cycle of the river and the natural process of delta formation. According to EPA, a large portion of the state's coastal wetlands have undergone and continue to undergo severe deprivation of sediments and nutrients that has led to the breakup of the natural system. In addition, EPA believes that many of Louisiana's wetlands have become isolated from the riverine sources that created them and are becoming stagnant and starved for nutrients and organic and inorganic sediments. Note that restoring these eroding wetlands involves supplying nutrients to these areas through managed Mississippi River diversions.

According to EPA's understanding, if any future diversion from the Mississippi River or other tributaries will increase flow, the nonpoint source load allocation and TMDLs will also be increased proportionately. From EPA's current understanding, the diversion projects are supported by both state and federal agencies, including EPA and the USACE. The diversions are managed by the USACE and the state, and the projects include post-diversion monitoring to determine effectiveness of the project and to monitor water quality conditions.

Wasteload Allocation

The WLA portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. The point sources in the Sabine River Basin include wastewater facilities. WLAs are based on the current flow levels. No MS4s were identified in the Sabine River Basin.

For fecal coliform bacteria, LDEQ's policy is to set wastewater permit limits no higher than water quality criteria (i.e., criteria are met at end-of-pipe). As long as point source discharges of treated wastewater contain bacteria levels at or below these permit limits, they should not be a cause of exceedances of water quality criteria. Therefore, no change in the permit limits is required. Table 4-3 lists the individual fecal coliform bacteria WLAs for each point source.

Table 4-3. Fecal coliform bacteria WLAs for the Sabine River Basin

Subsegment	Permit number	Outfall	Flow (gpd)	FCB monthly avg (colonies/100 mL)	FBC load (1×10^9 colonies/day)
110202	LA0055867	001	143,000	200	1.0826
	LAG530498	001	100	200	0.0008
	LAG540001	001	350	200	0.0026
	LAG540700	001	8600	200	0.0651
	Total				**1.1511**
110401	LA0093939	001	125,000	200	0.9464
	Total				**0.9464**
110501	LAG530060	001	1,185	200	0.0090
	LAG560106		50,000[a]	200[a]	0.3785
	Total				**0.3875**
110504	LAG530097	001	4,200	200	0.0318
	LAG530162	001	619	200	0.0047
	LAG530254	001	1,000	200	0.0076
	LAG530475	001	3,600	200	0.0273
	LAG540288	001	7,800	200	0.0591
	Total				**0.1304**

[a] This flow is standard for LAG560106 general permits. Limits are general limits for monthly summer averages.

Load Allocation

The load allocation is the portion of the TMDL assigned to natural background loadings as well as nonpoint sources such as septic tank leakage, wildlife, and agricultural practices. For this TMDL, that LA was calculated by subtracting the WLA, MOS, and FG from the total TMDL. LAs were not allocated to separate nonpoint sources; due to the lack of available source characterization data. The LAs are presented in Table 4-2.

4.3 Seasonality and Critical Conditions

The federal regulations at 40 CFR 130.7 require that TMDLs include seasonal variations and take into account critical conditions for streamflow, loading, and water quality parameters. For this TMDL, fecal coliform bacteria loadings for subsegments with primary contact recreation as the designated use were determined for winter and summer on the basis of seasonal water quality criteria, thus accounting for seasonality. In addition, the sampling results for fecal coliform bacteria were plotted over time and reviewed for any seasonal patterns (see Section 3.2).

By accounting for critical conditions, the TMDL makes sure that water quality standards are maintained for infrequent occurrences and not only for average conditions. For fecal coliform bacteria, the water quality criteria include values that must not be exceeded more than 25 percent of the time (primary and secondary contact recreation).

Because of the way the criteria are written (i.e., including critical and noncritical conditions), the TMDL for the pollutant of concern can be developed by reviewing pollutant loads at all flow conditions within applicable periods of the year and evaluating the percentage of values exceeding the criteria. The load duration curve, which determines the allowable loading at a wide range of flows, was chosen as the approach for these TMDLs (see Section 4.1). Therefore, the TMDLs were calculated at all flows rather than at a single critical flow.

4.4 Margin of Safety

The margin of safety (MOS) is the portion of the pollutant loading reserved to account for any uncertainty in the data. There are two ways to incorporate the MOS (USEPA 1991). One way is to implicitly incorporate the MOS by using conservative model assumptions to develop allocations. The other way is to explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For this analysis, the MOS is explicit: 10 percent of each targeted TMDL was reserved as the MOS to account for any uncertainty in the TMDL. Using 10 percent of the TMDL load provides an additional level of protection to the designated uses of the subsegments of concern.

4.5 Future Growth

While the MOS is an allocation for scientific uncertainly, future growth is an allocation for growth. Ten percent of the load was allocated for future growth in the area that is covered by the TMDL. This includes future urban development, including point sources and MS4 areas, and agricultural and other typical nonpoint source contributing areas.

5 FUTURE ACTIVITIES

5.1 TMDL Implementation Strategies

Wasteload allocations will be implemented through Louisiana Pollution Discharge Elimination System (LPDES) permit procedures.

Load allocations will be addressed through the LDEQ Nonpoint Source Management Program. Louisiana's *Nonpoint Source Management Plan* (LDEQ 2000) states that TMDLs are being developed through a close relationship between LDEQ and EPA Region 6. It further states that "management strategies outlined within this document (both statewide and watershed) will be implemented in each of the watersheds where water quality problems have been attributed to nonpoint sources of pollution." On page ii, Objective 3 of the watershed management strategies is to "utilize pollutant load reductions of the TMDL to develop nonpoint source pollution reduction strategies for each of the watersheds...that have water quality problems identified." In addition, Objective 7 provides a tracking process for evaluating progress in reducing loadings of fecal coliform bacteria.

The plan includes a discussion of a number of nonpoint source activities and provides best management practices (BMPs) that can be used to achieve the nonpoint source load reductions for fecal coliform bacteria established in the TMDLs. The plan broadly discusses programs including agriculture, forestry, home sewerage systems, hydromodification, urban runoff, construction, and resource extraction. Provided with each BMP is an evaluation of the effectiveness of that BMP, given as a high, medium, or low ranking. Additional evaluations should be conducted to determine the most likely source of impairment in this watershed and to identify localized hot spots to be targeted for effective BMP implementation. These and other BMPs may be implemented at a scale adequate to achieve the load reductions established in the TMDL.

5.2 Water Quality Monitoring Activities

LDEQ uses funds provided under section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to run a program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations using appropriate sampling methods and procedures to ensure the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, develop a long-term database for water quality trend analysis, and monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program are used to develop the state's biennial section 305(b) report (*Water Quality Inventory*) and the section 303(d) list of impaired waters. This information is also used in establishing priorities for LDEQ's nonpoint source program.

LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled on a 4-year cycle. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the 4-year cycle. Sampling is conducted monthly to yield approximately 12 samples per site during each year the site is monitored. Sampling sites are located where they are considered representative of the waterbody. Under the current monitoring schedule, approximately one-half of the state's waters are newly assessed for section 305(b) and section 303(d) listing purposes for each biennial cycle, with sampling occurring statewide each year. The 4-year cycle follows an initial 5-year rotation that covered all basins in the state according to the TMDL priorities. Monitoring will allow LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the section 303(d) list of impaired waterbodies.

6 PUBLIC PARTICIPATION

Federal regulations require EPA to notify the public and seek comment concerning TMDLs that they prepare. This TMDL was developed under contract to EPA, and EPA is seeking comments, information, and data from the public and any other interested party. Comments and additional information submitted during this public comment period will be used to inform or revise this TMDL. The comments and responses will be included in an appendix in the final draft of this TMDL. EPA will submit the final TMDL to the LDEQ for implementation and incorporation into LDEQ's current water quality management plan.

7 REFERENCES

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Appendix A
Fecal Coliform Bacteria Water Quality Summary, Data, and Plots

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Table A-1. Summary of fecal coliform bacteria data in the Sabine River Basin

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100 ml	Maximum MPN/ 100 ml	Mean MPN/ 100 ml	Median MPN/ 100 ml	Number of observations above criterion[a]	% of observations above criterion[a]
May 1 through October 31, 2002									
1156/ 110202	Pearl Creek northwest of Burr Ferry, LA	5/21/02–10/21/02	6	2	5,000	1,160	305	3	50%
1160/ 110401	Bayou Toro northeast of Toro, LA	5/21/02–10/21/02	6	23	16,000	2,914	155	2	33%
1161/ 110402	Bayou Toro at Louisiana Hwy 392, LA	5/21/02–10/21/02	6	30	2,200	558	145	2	33%
1162/ 110501	West Anacoco Creek at US Hwy 171, LA	5/20/02–10/15/02	5	130	1,100	646	800	3	60%
1165/ 110504	Bayou Anacoco at Standard, LA	5/20/02–10/15/02	6	70	500	258	205	2	33%
November 1 through April 30, 2002									
1156/ 110202	Pearl Creek northwest of Burr Ferry, LA	11/19/02–4/16/02	6	30	1,600	372	135	0	0%
1160/ 110401	Bayou Toro northeast of Toro, LA	11/19/02–4/16/02	6	70	1,700	512	360	0	0%

Table A-1. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100 ml	Maximum MPN/ 100 ml	Mean MPN/ 100 ml	Median MPN/ 100 ml	Number of observations above criterion[a]	% of observations above criterion[a]
1161/ 110402	Bayou Toro at Louisiana Hwy 392, LA	11/19/02–4/16/02	6	23	900	236	100	0	0%
1162/ 110501	West Anacoco Creek at US Hwy 171, LA	11/18/02–4/15/02	6	70	220	90	95	0	0%
1165/ 110504	Bayou Anacoco at Standard, LA	11/18/02–-4/15/02	6	2	110	42	26	0	0%

[a] Primary contact recreation water quality criteria for fecal coliform bacteria: No more than 25 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform density of 400/100mL from May 1 through October 31. During the nonrecreational period of November 1 through April 30, the criteria for secondary contact recreation shall apply (no more than 25 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform density of 2,000/100mL).

Table A-2. Fecal coliform bacteria observations at Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156)

Summer			Winter		
Date	Result (#/100 mL)	Flow[a] (cfs)	Date	Result (#/100 mL)	Flow[a] (cfs)
05/21/02	2	19	01/28/02	30	131
06/18/02	50	6	02/25/02	110	93
07/23/02	110	7	03/26/02	1,600	208
08/20/02	1,300	16	04/16/02	220	92
09/23/02	500	16	11/19/02	140	67
10/21/02	5,000	428	12/17/02	130	148

[a] USGS Gage 0802550

Table A-3. Fecal coliform bacteria observations at Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160)

Summer			Winter		
Date	Result (#/100 mL)	Flow[a] (cfs)	Date	Result (#/100 mL)	Flow[a] (cfs)
05/21/02	140	19	01/28/02	500	131
06/18/02	23	6	02/25/02	220	93
07/23/02	50	7	03/26/02	1,700	208
08/20/02	1,100	16	04/16/02	70	92
09/23/02	170	16	11/19/02	80	67
10/21/02	16,000	428	12/17/02	500	148

[a] USGS Gage 0802550

Table A-4. Fecal coliform bacteria observations for Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161)

Summer			Winter		
Date	Result (#/100 mL)	Flow[a] (cfs)	Date	Result (#/100 mL)	Flow[a] (cfs)
05/21/02	30	19	01/28/02	900	131
06/18/02	70	6	02/25/02	23	93
07/23/02	30	7	03/26/02	240	208
08/20/02	220	16	04/16/02	70	92
09/23/02	800	16	11/19/02	50	67
10/21/02	2,200	428	12/17/02	130	148

[a] USGS Gage 0802550

Table A-5. Fecal coliform bacteria observations for West Anacoco Creek (subsegment 110501) at US Highway 171, Louisiana (station 1162)

Summer			Winter		
Date	Result (#/100 mL)	Flow[a] (cfs)	Date	Result (#/100 mL)	Flow[a] (cfs)
05/20/02	900	60	01/22/02	220	395
06/17/02	1,100	26	02/19/02	80	252
07/22/02	800	25	03/25/02	80	234
08/19/02	130	49	04/15/02	70	692
10/15/02	300	89	11/18/02	110	221
			12/16/02	110	1,930

[a] USGS Gage 08028000

Table A-6. Fecal coliform bacteria observations for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165)

Summer			Winter		
Date	Result (#/100 mL)	Flow[a] (cfs)	Date	Result (#/100 mL)	Flow[a] (cfs)
05/20/02	500	60	01/22/02	2	395
06/17/02	500	26	02/19/02	22	252
07/22/02	70	25	03/25/02	80	234
08/19/02	300	49	04/15/02	8	692
09/23/02	70	311	11/18/02	110	221
10/15/02	110	89	12/16/02	30	1,930

[a] USGS Gage 08028000

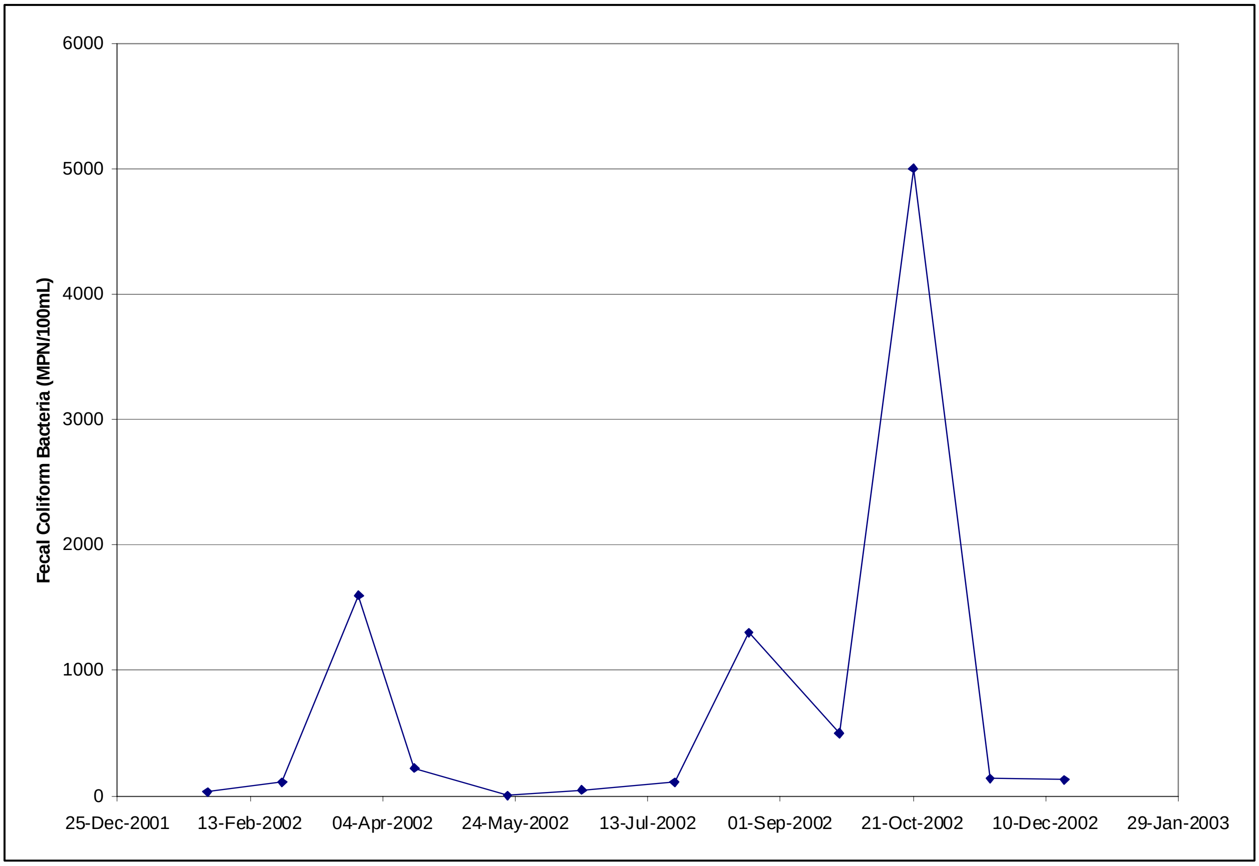

Figure A-1. Fecal coliform bacteria observations at Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156).

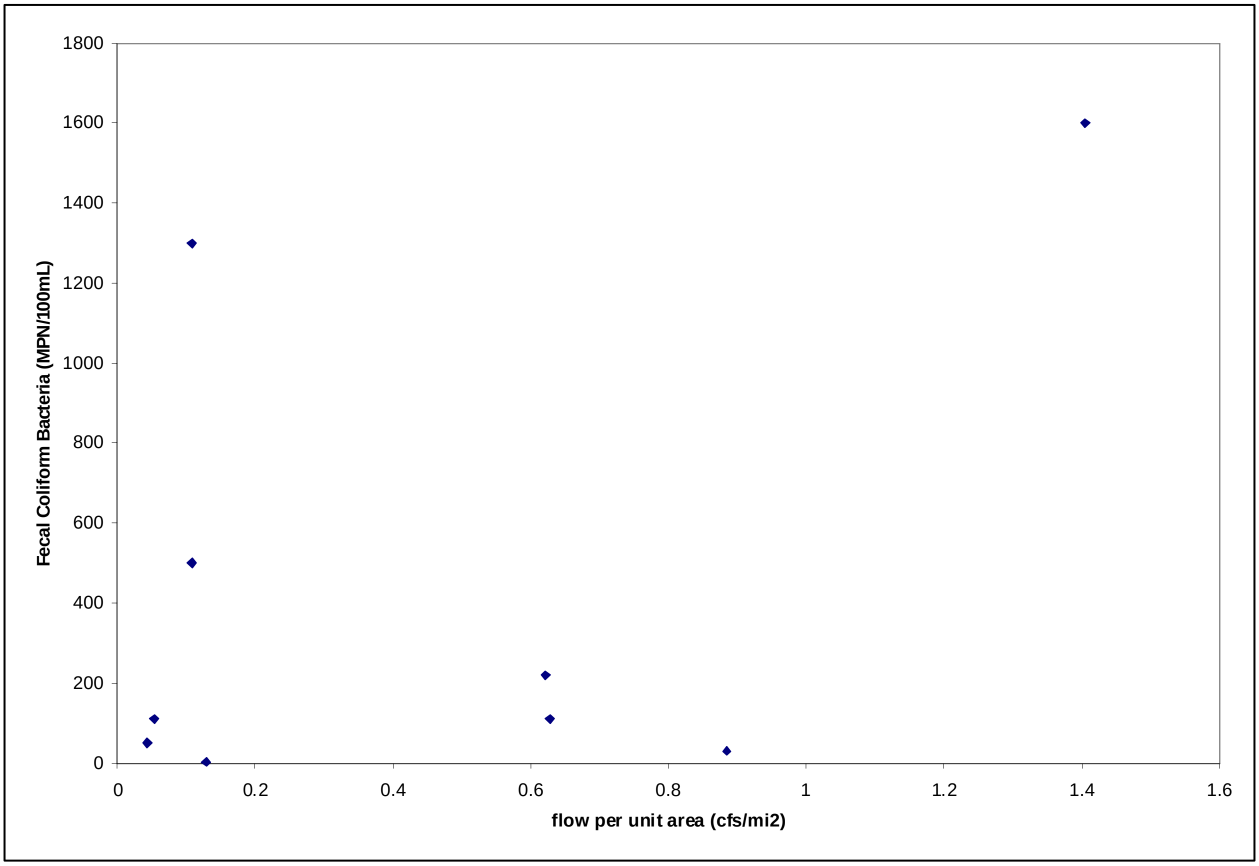

Figure A-2. Fecal coliform bacteria versus flow at Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156).

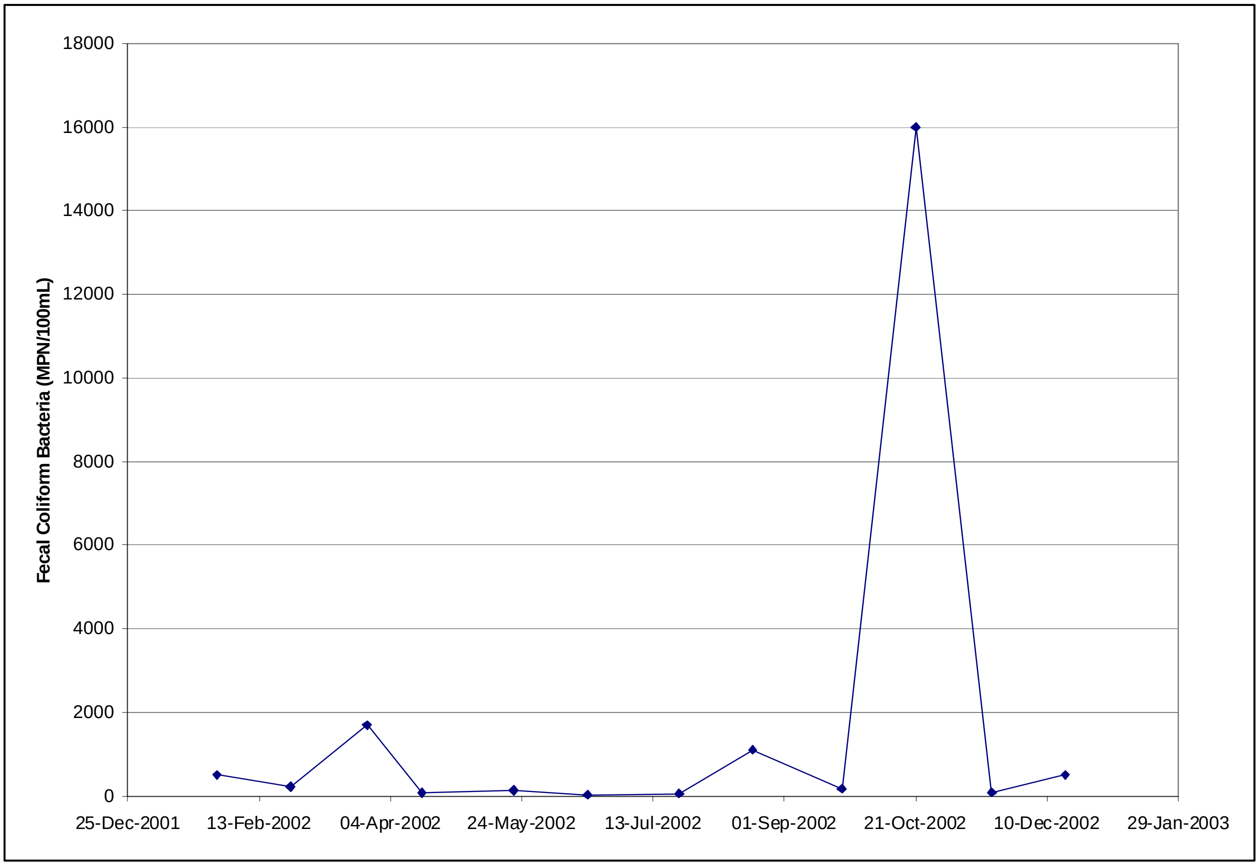

Figure A-3. Fecal coliform bacteria observations at Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160).

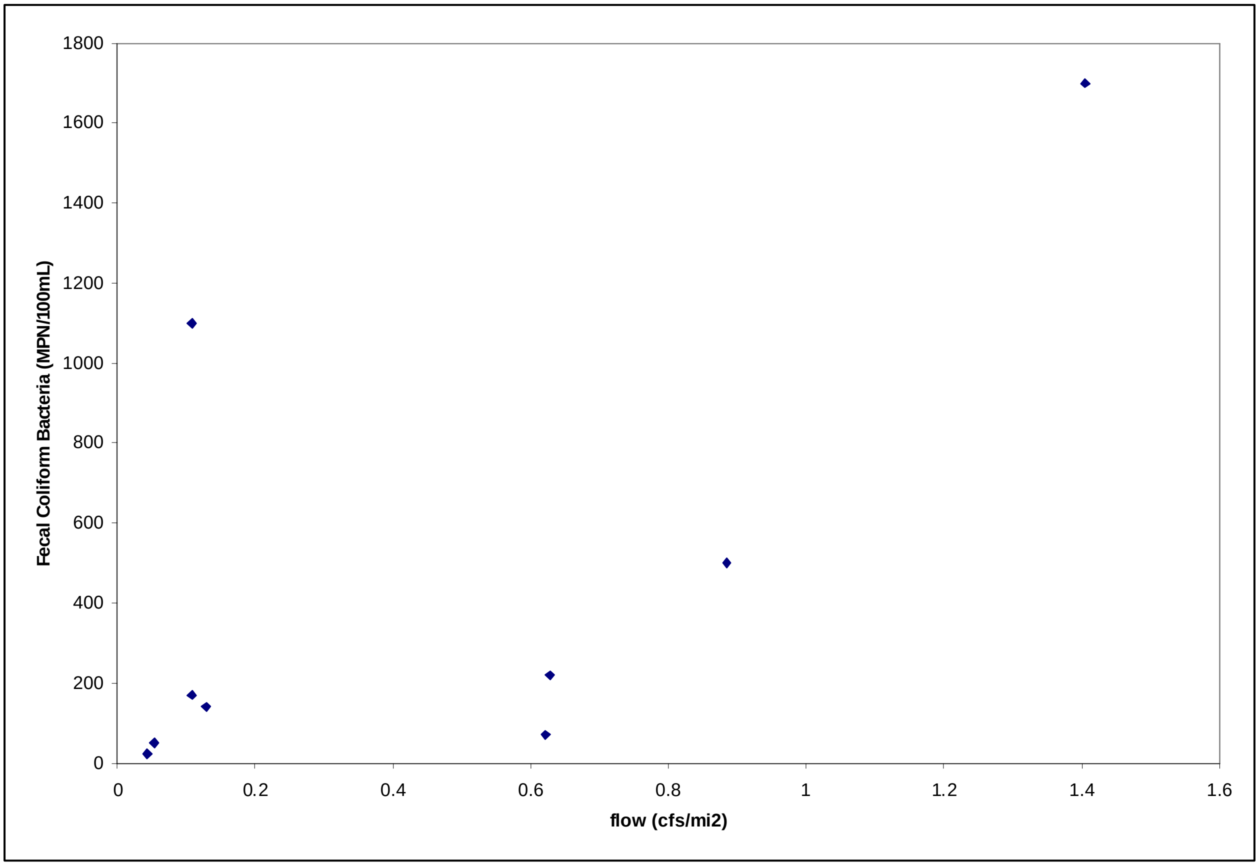

Figure A-4. Fecal coliform bacteria versus flow at Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160).

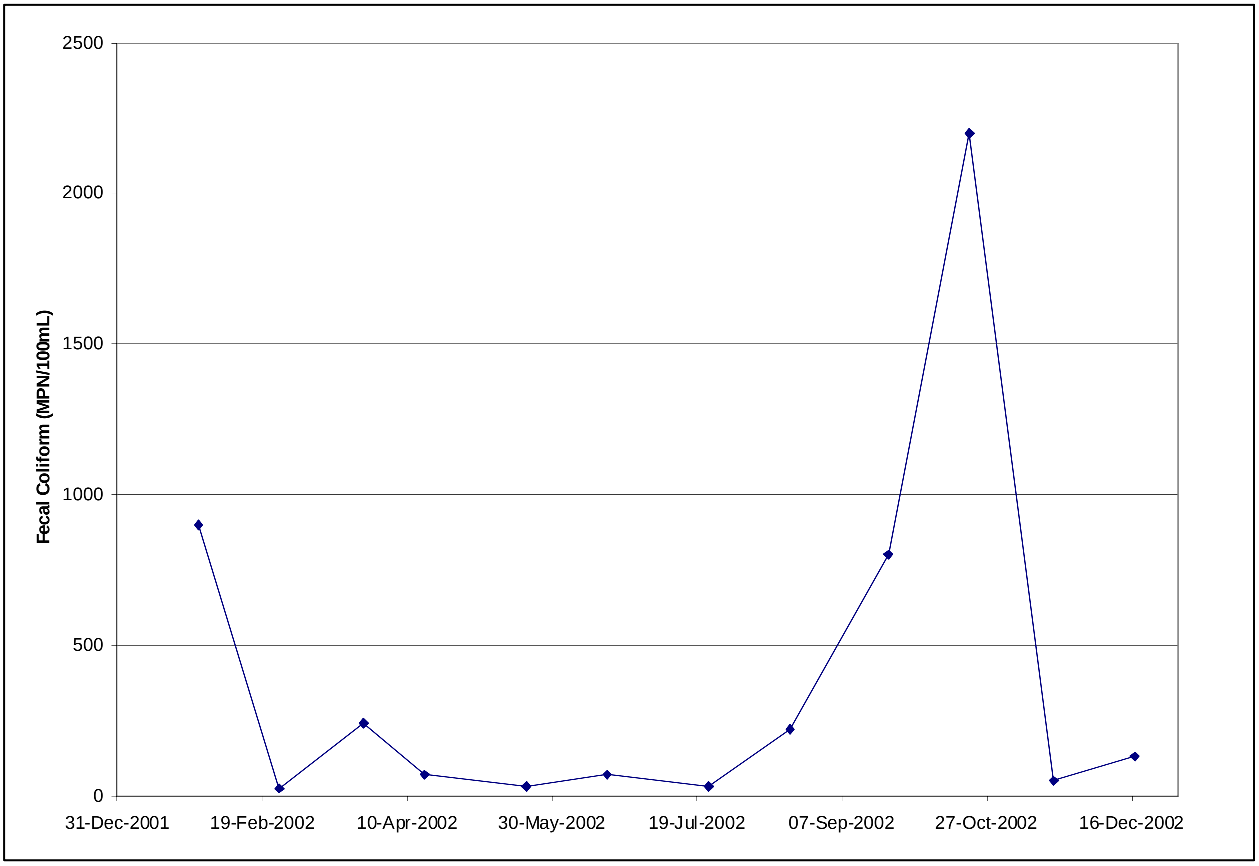

Figure A-5. Fecal coliform bacteria observations for Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161).

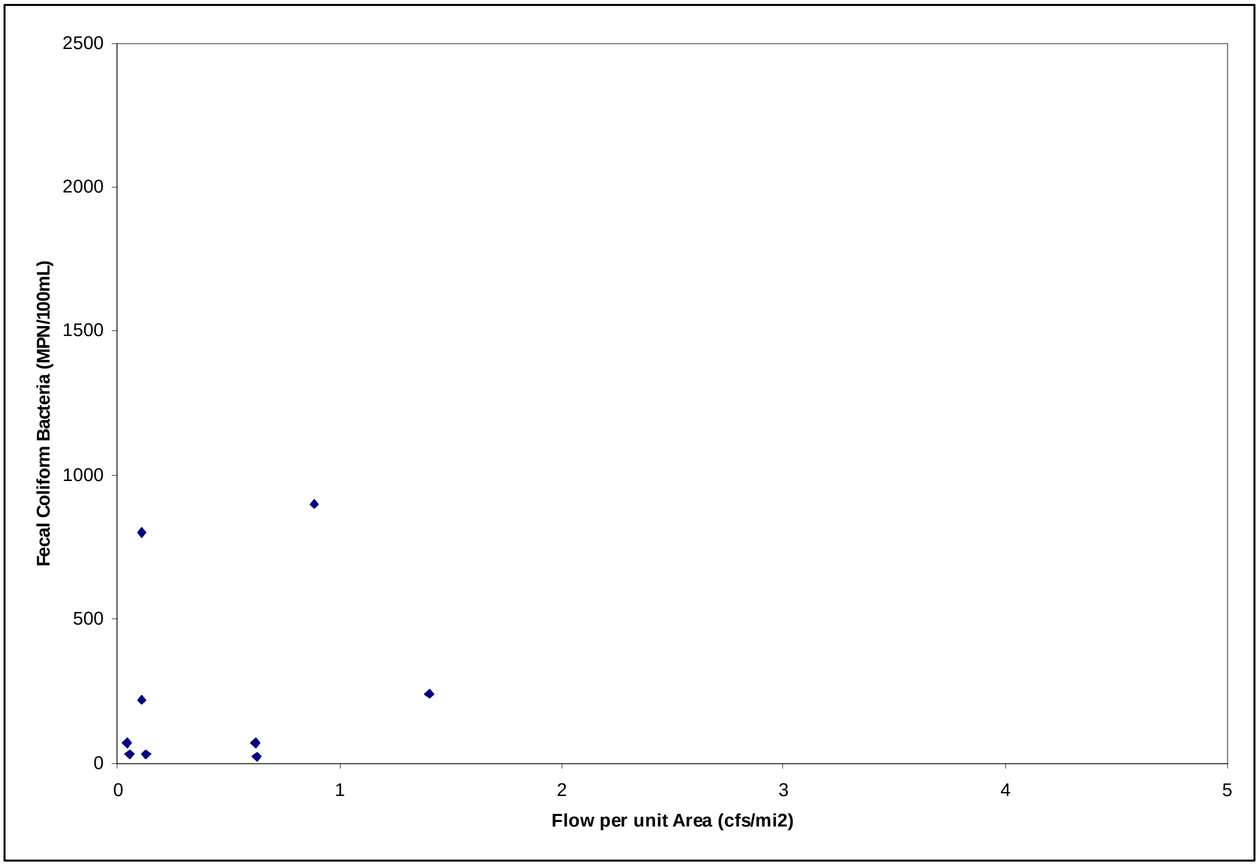

Figure A-6. Fecal coliform bacteria versus flow at Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161).

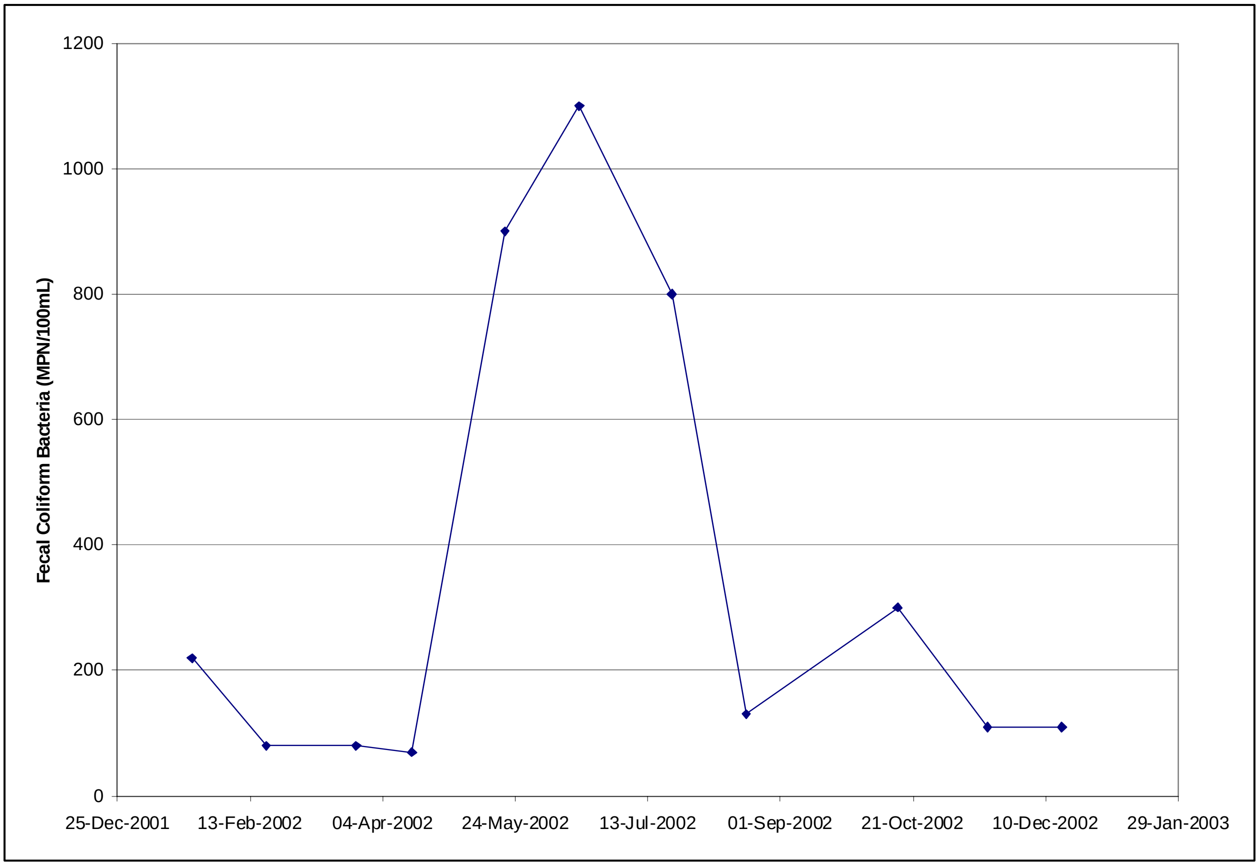

Figure A-7. Fecal coliform bacteria observations at West Anacoco Creek (subsegment 110501) at US Highway 171, Louisiana (station 1162).

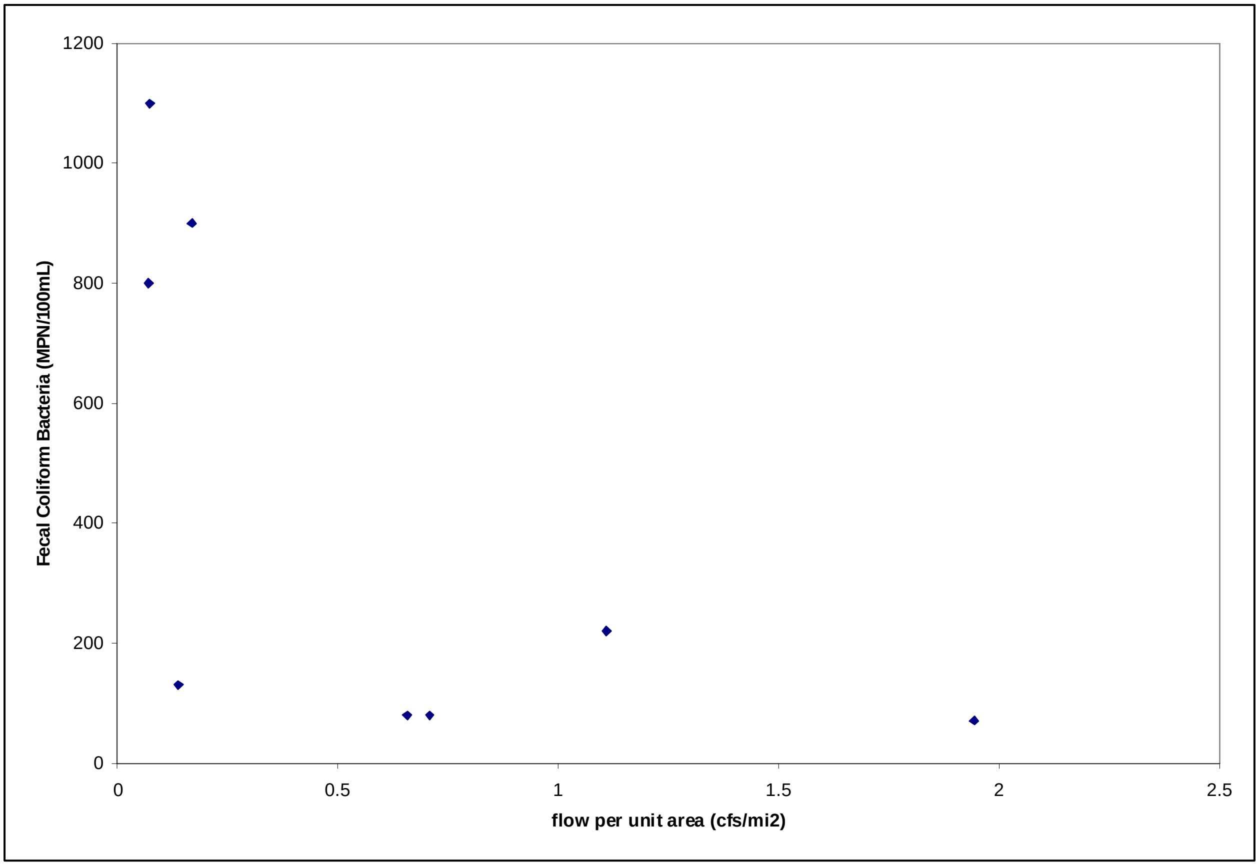

Figure A-8. Fecal coliform bacteria versus flow at West Anacoco Creek (subsegment 110501) at US Highway 171, Louisiana (station 1162).

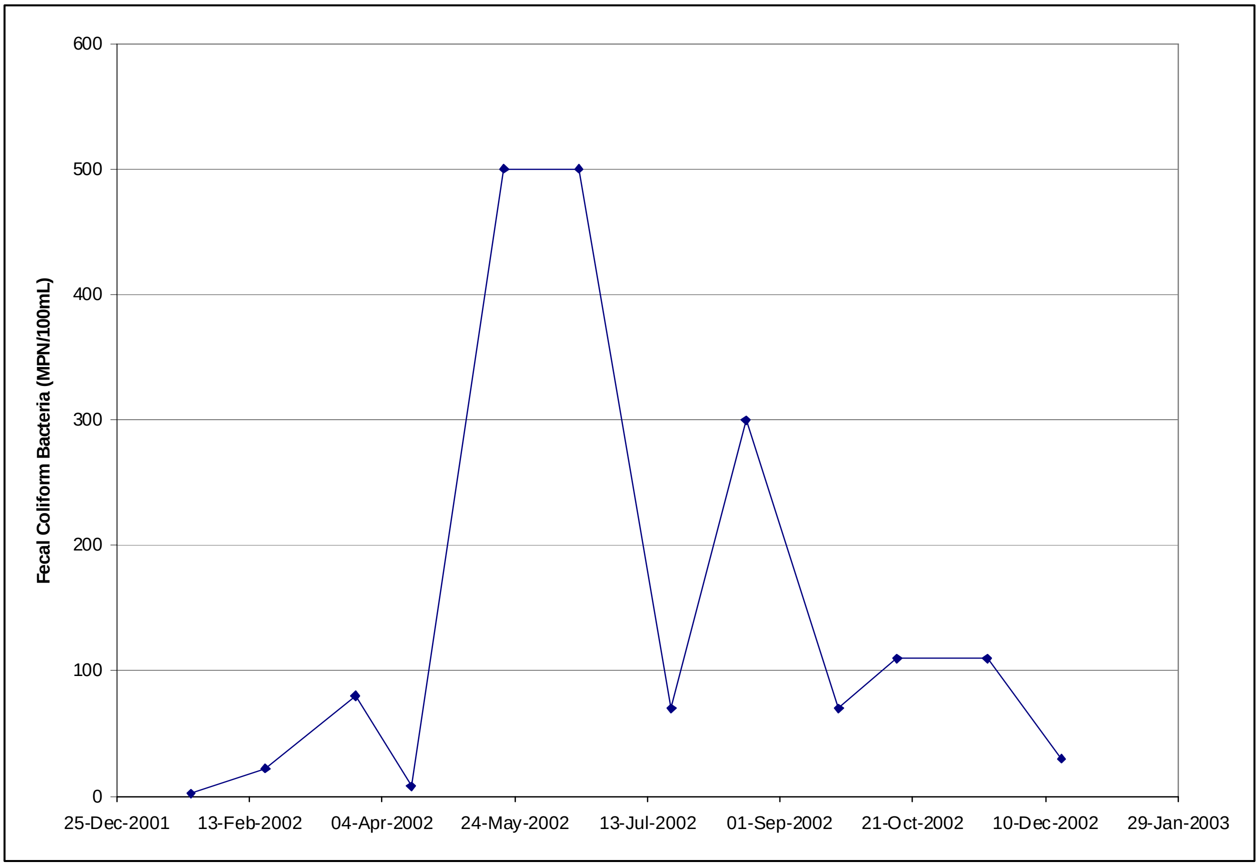

Figure A-9. Fecal coliform bacteria observations for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165).

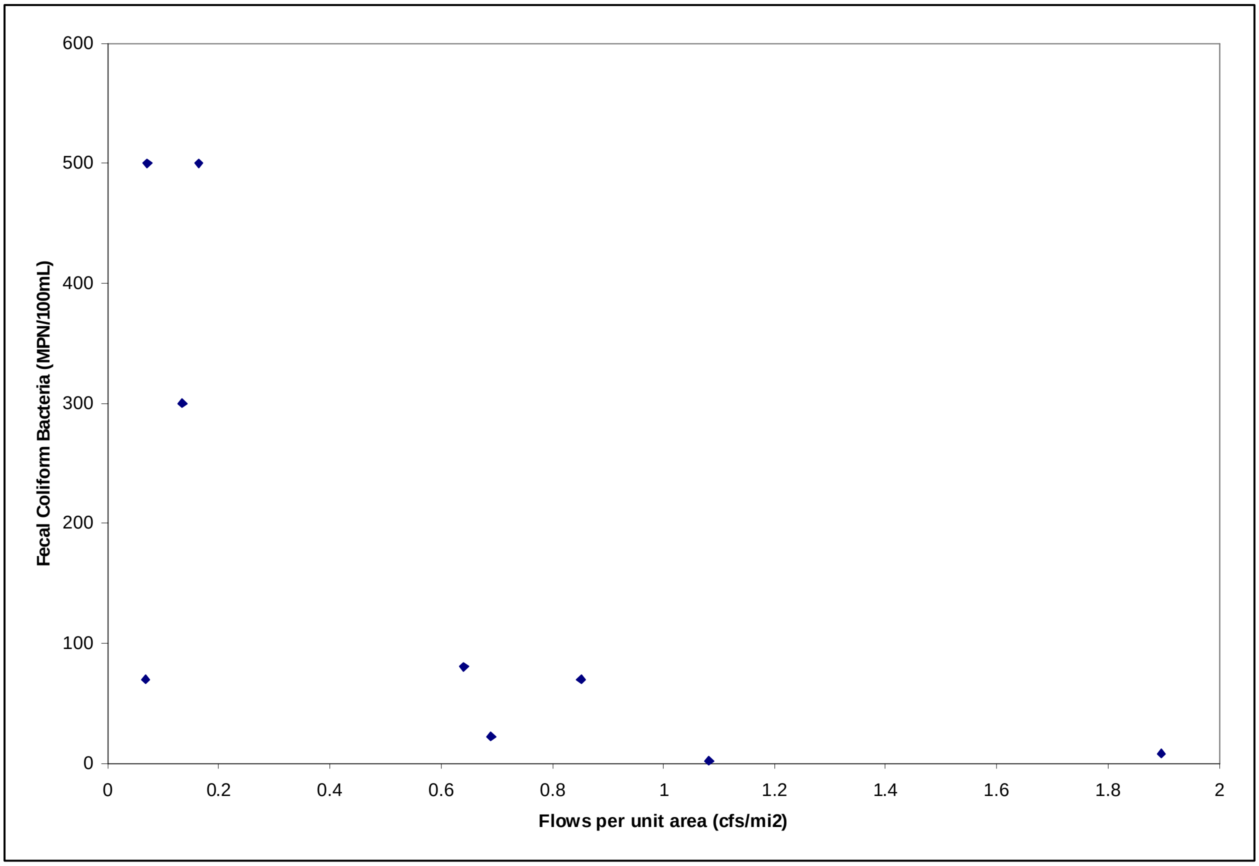

Figure A-10. Fecal coliform bacteria versus flow for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165).

Appendix C
Sabine River Basin Load Duration Curves and Plots for Fecal Coliform Bacteria: Summer

Figure C-1. Summer fecal coliform bacteria load duration curve for Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156). 1
Figure C-2. Summer fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160). 2
Figure C-3. Summer fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161). 3
Figure C-4. Summer fecal coliform bacteria load duration curve for West Anacoco Creek (subsegment 110501) at US Highway 171 (station 1162). 4
Figure C-5. Summer fecal coliform bacteria load duration curve for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165). 5

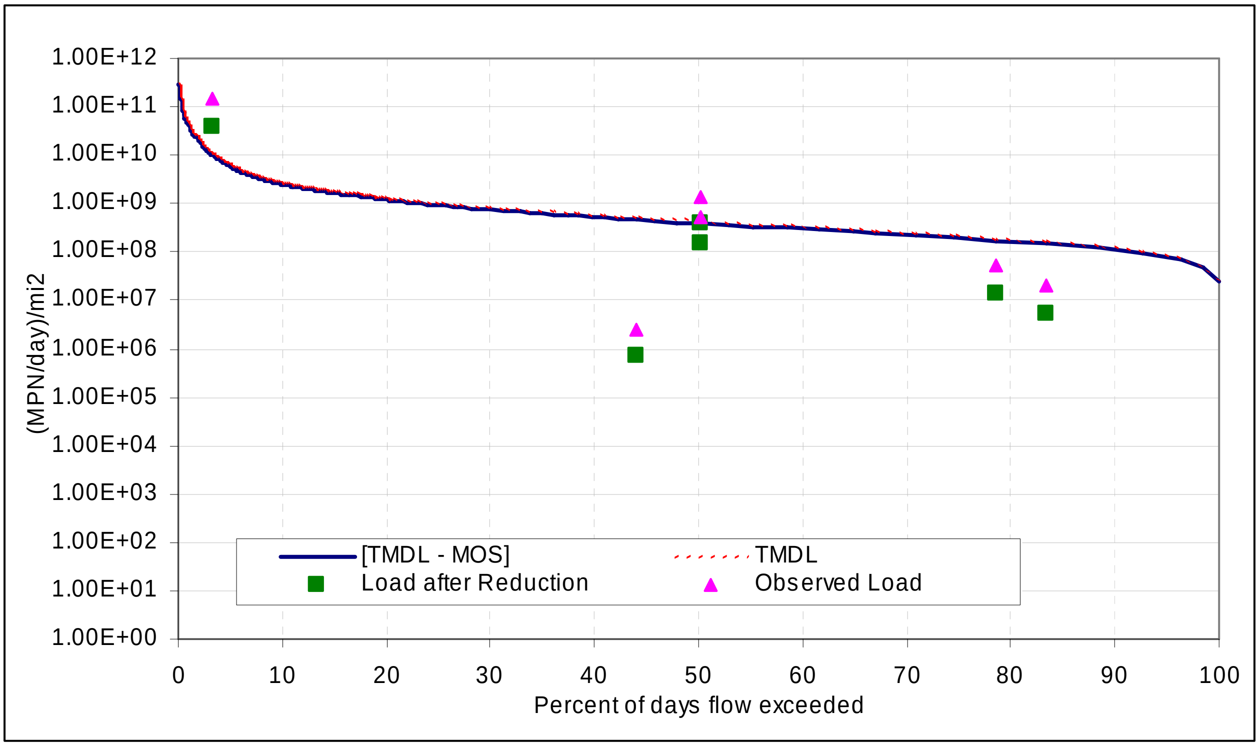

Figure C-1. Summer fecal coliform bacteria load duration curve for Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156).

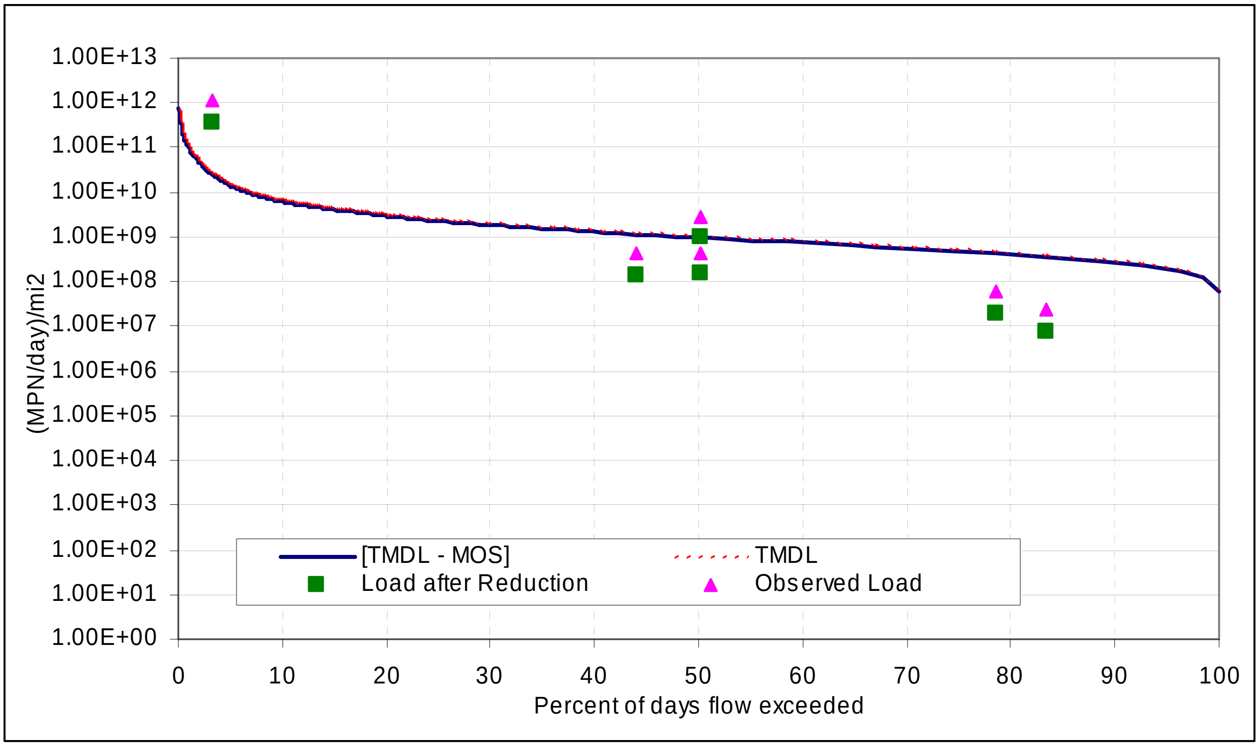

Figure C-2. Summer fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160).

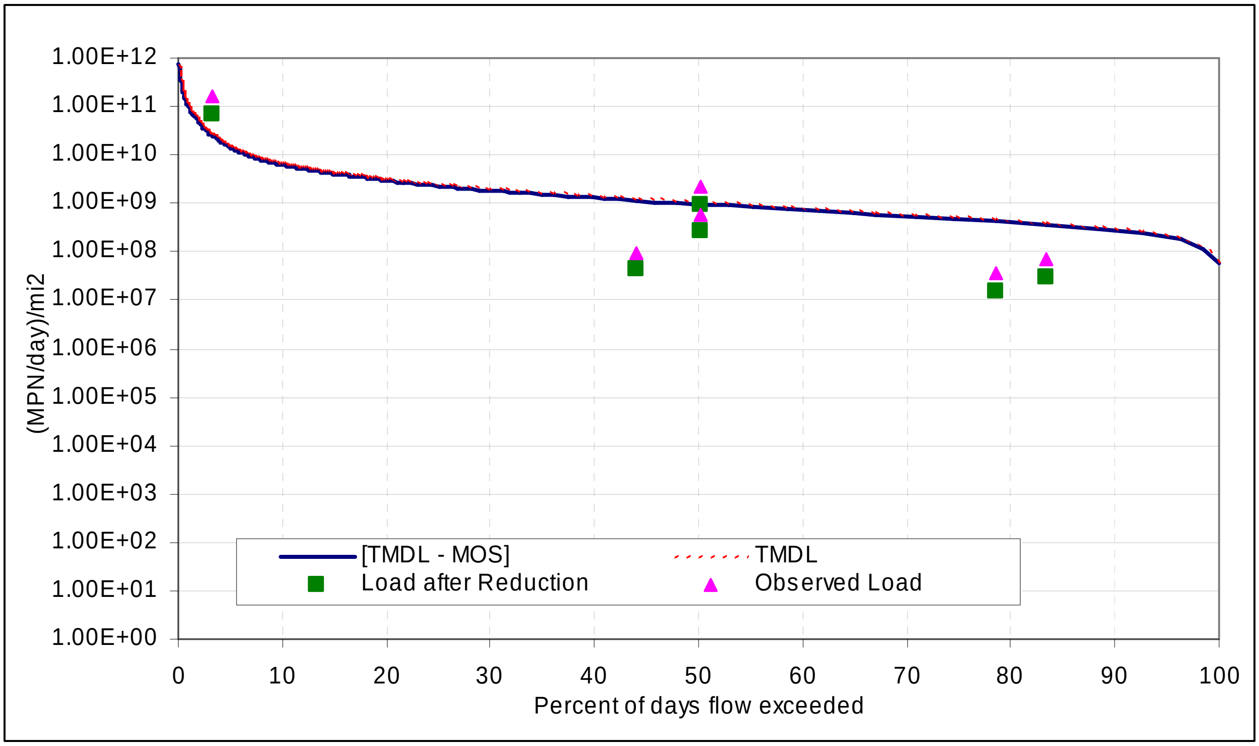

Figure C-3. Summer fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161).

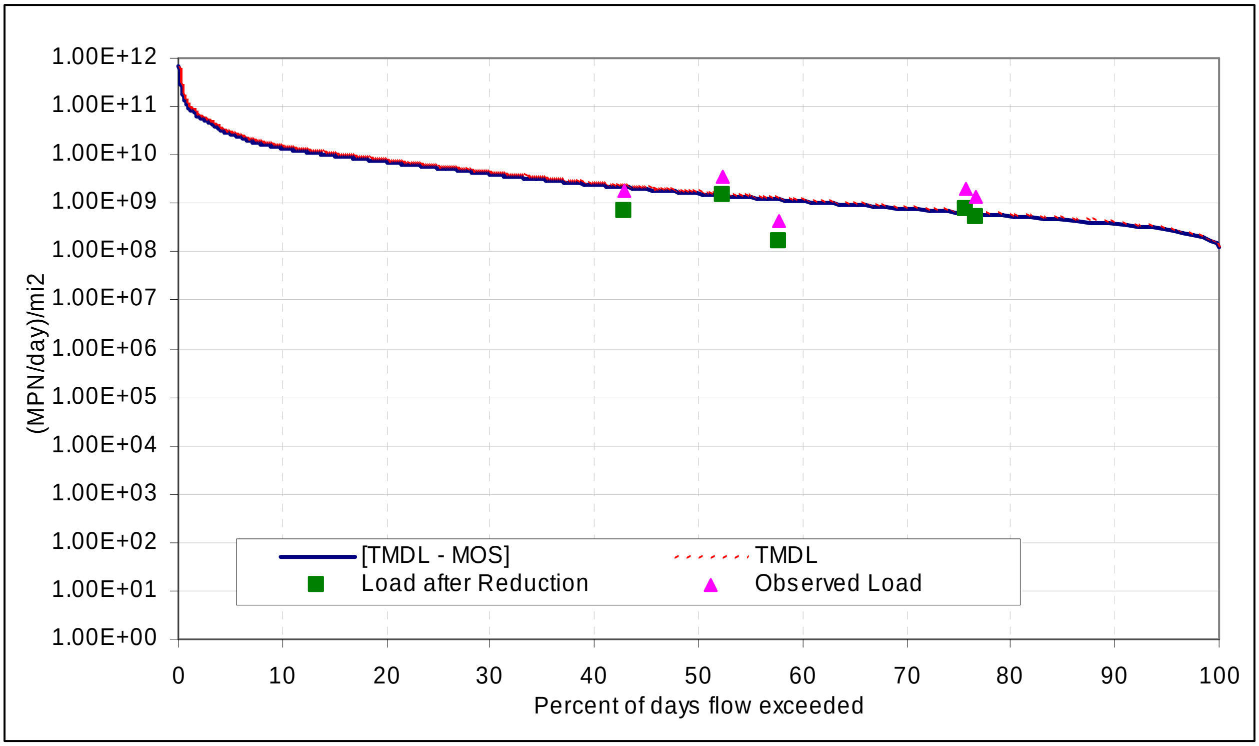

Figure C-4. Summer fecal coliform bacteria load duration curve for West Anacoco Creek (subsegment 110501) at US Highway 171 (station 1162).

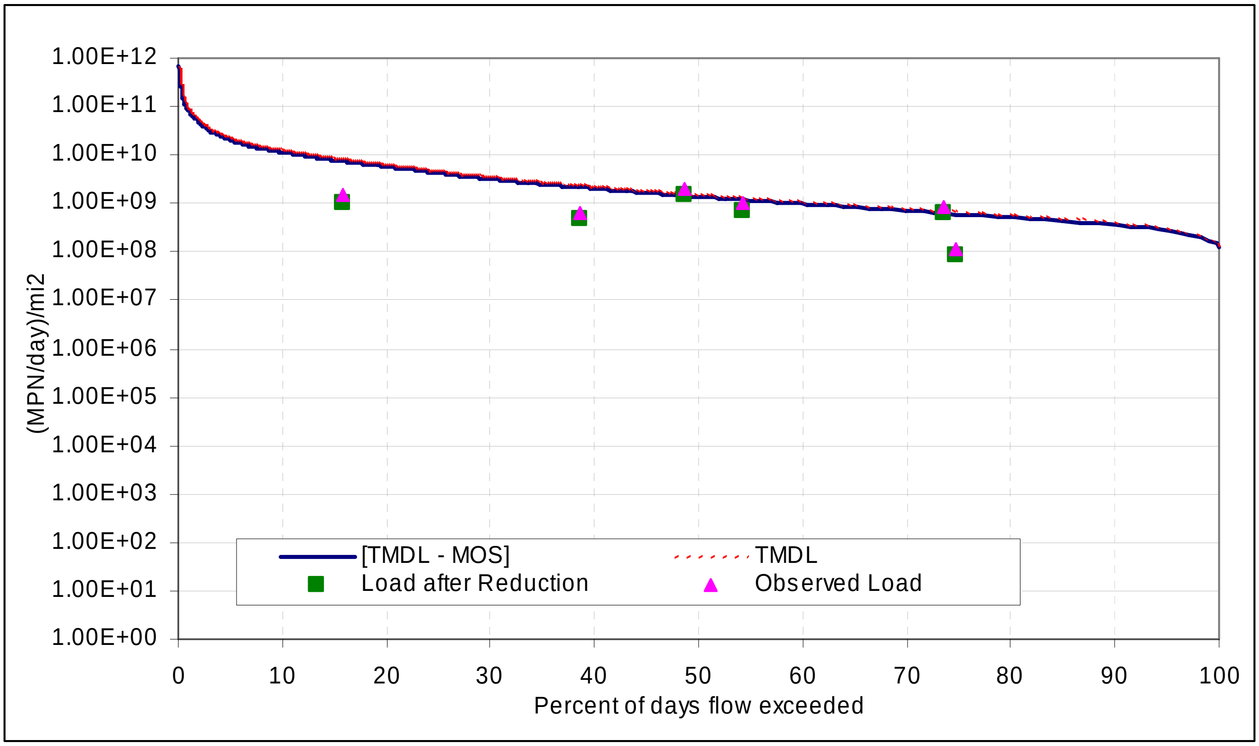

Figure C-5. Summer fecal coliform bacteria load duration curve for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165).

Appendix D
Sabine River Basin Load Duration Curves and Plots for Fecal Coliform Bacteria: Winter

Figure D-1. Winter fecal coliform bacteria load duration curve for Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156). 1
Figure D-2. Winter fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160). 2
Figure D-3. Winter fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161). 3
Figure D-4. Winter fecal coliform bacteria load duration curve for West Anacoco Creek (subsegment 110501) at US Highway 171 (station 1162). 4
Figure D-5. Winter fecal coliform bacteria load duration curve for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165). 5

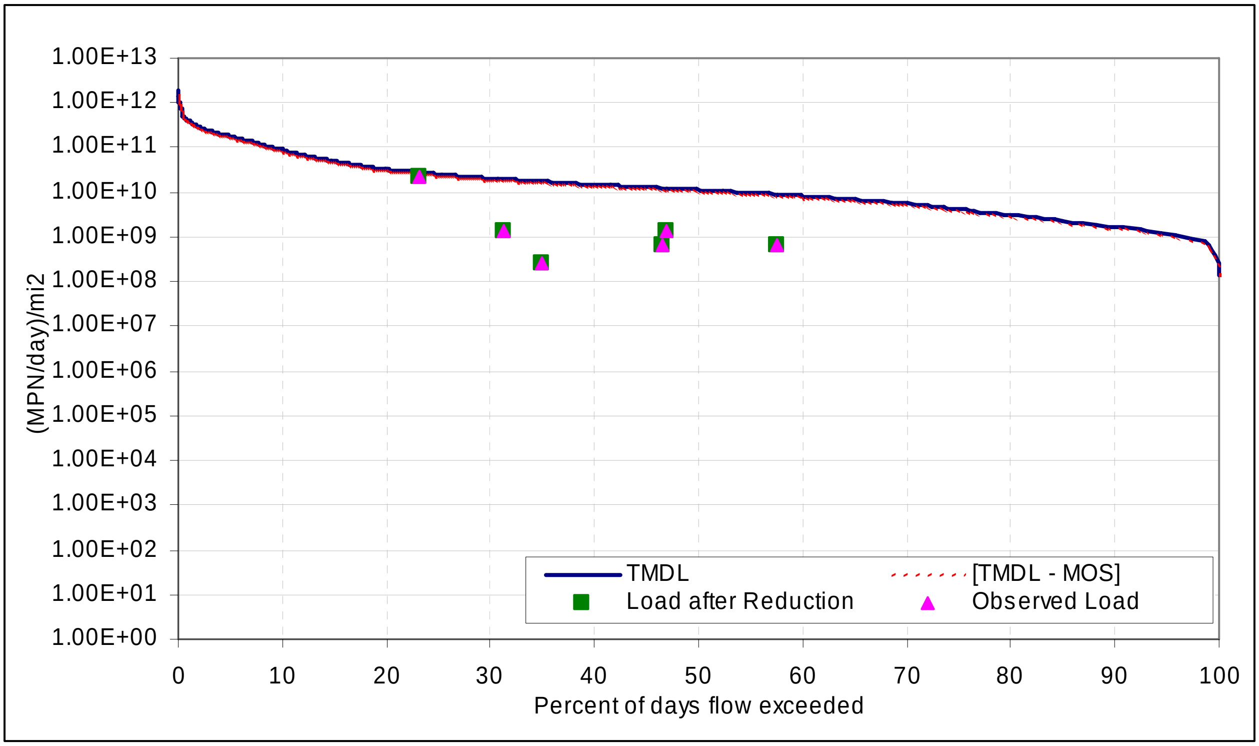

Figure D-1. Winter fecal coliform bacteria load duration curve for Pearl Creek (subsegment 110202) northwest of Burr Ferry, Louisiana (station 1156).

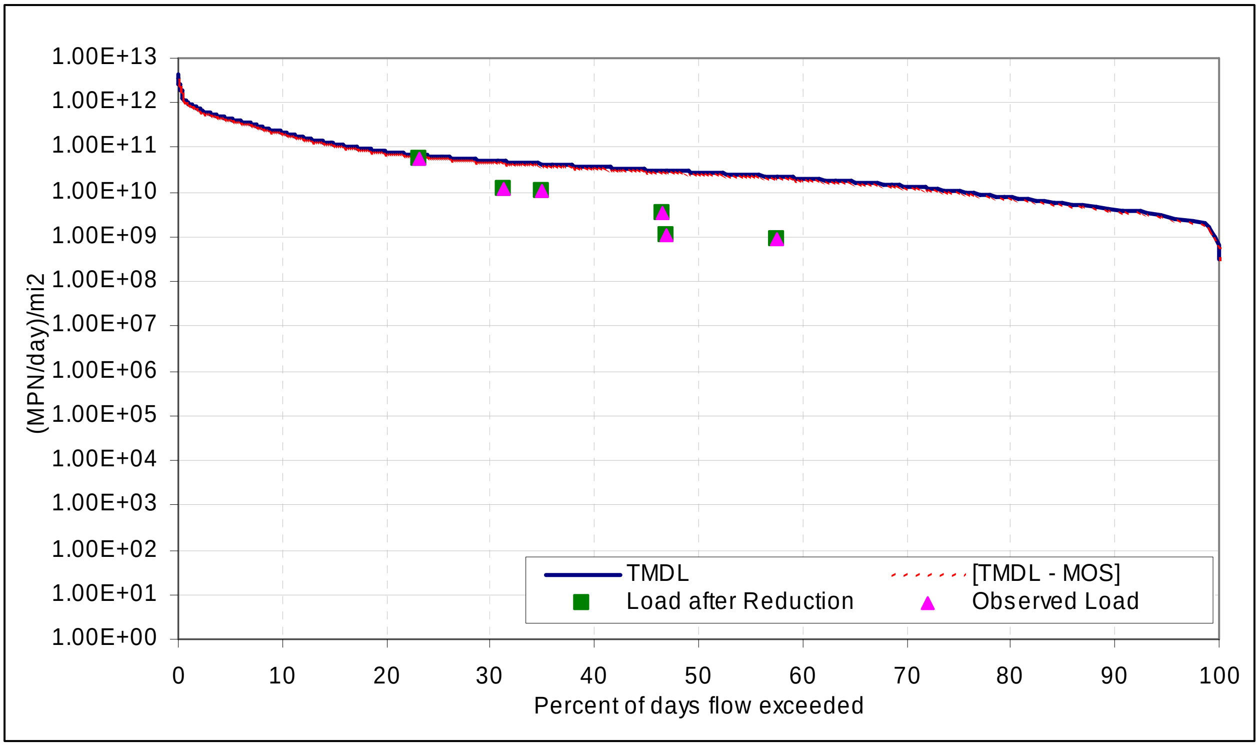

Figure D-2. Winter fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110401) northeast of Toro, Louisiana (station 1160).

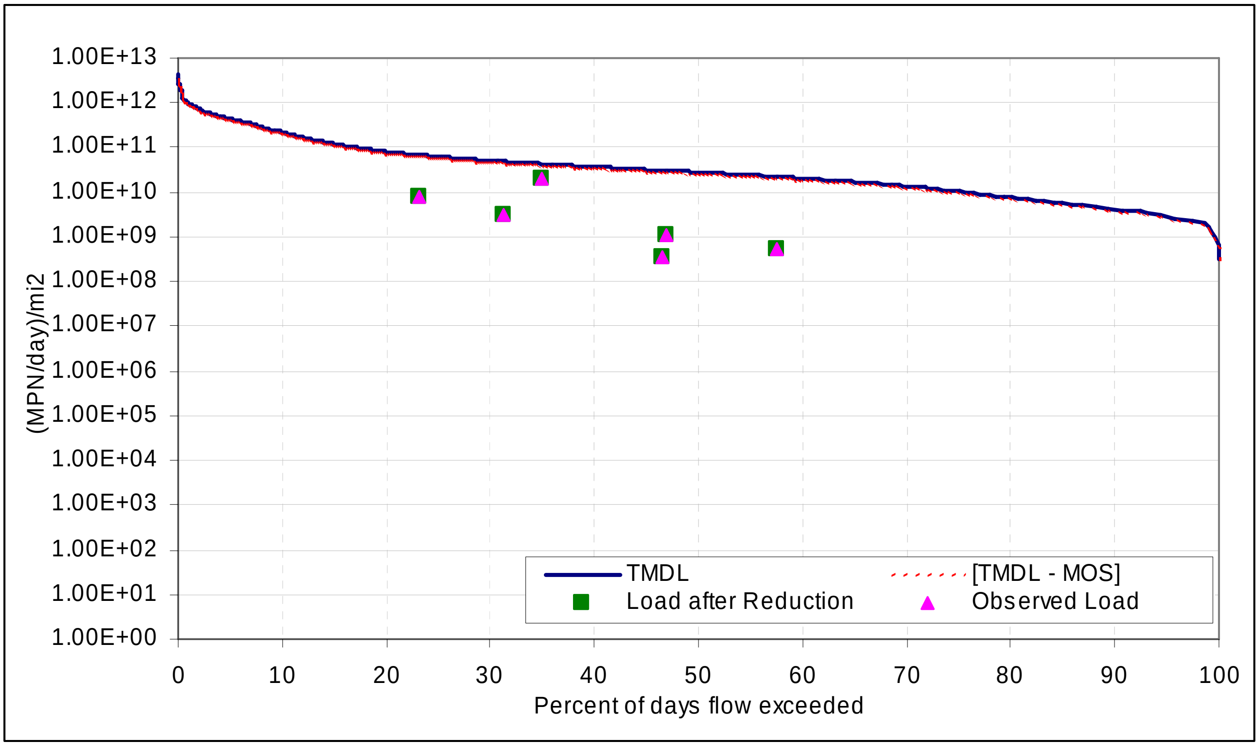

Figure D-3. Winter fecal coliform bacteria load duration curve for Bayou Toro (subsegment 110402) at Louisiana Highway 392 (station 1161).

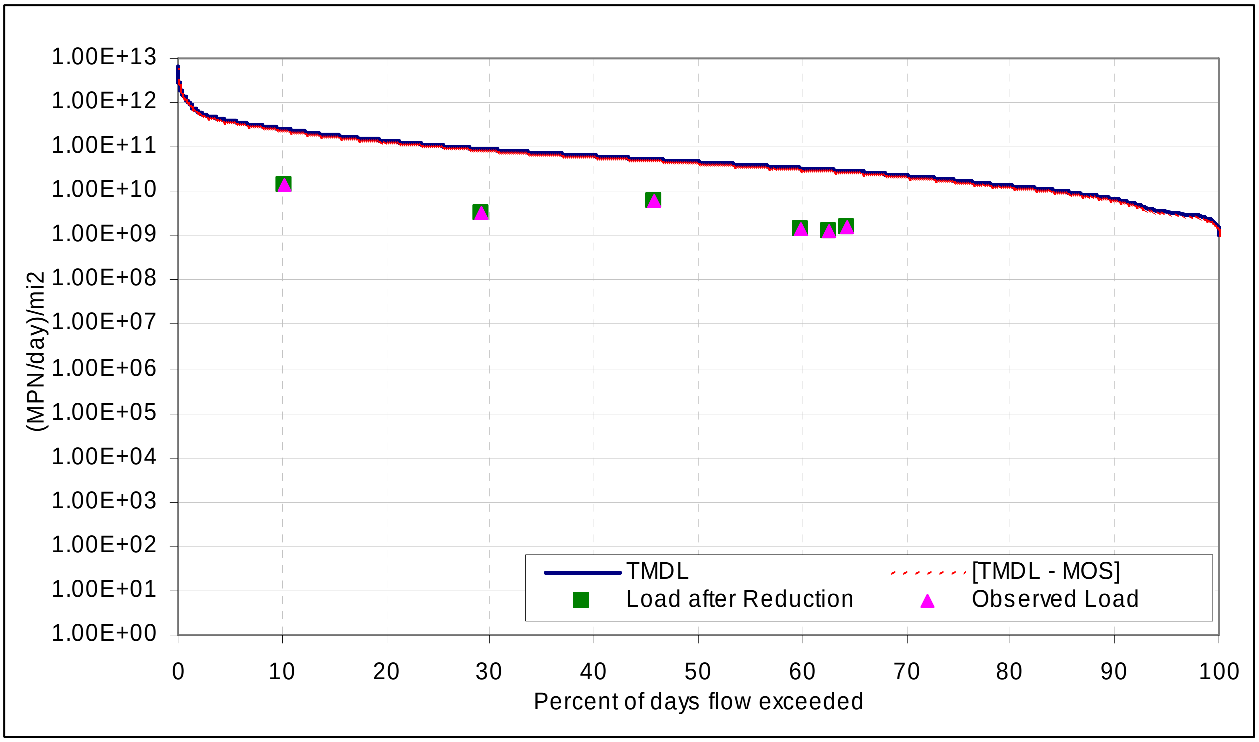

Figure D-4. Winter fecal coliform bacteria load duration curve for West Anacoco Creek (subsegment 110501) at US Highway 171 (station 1162).

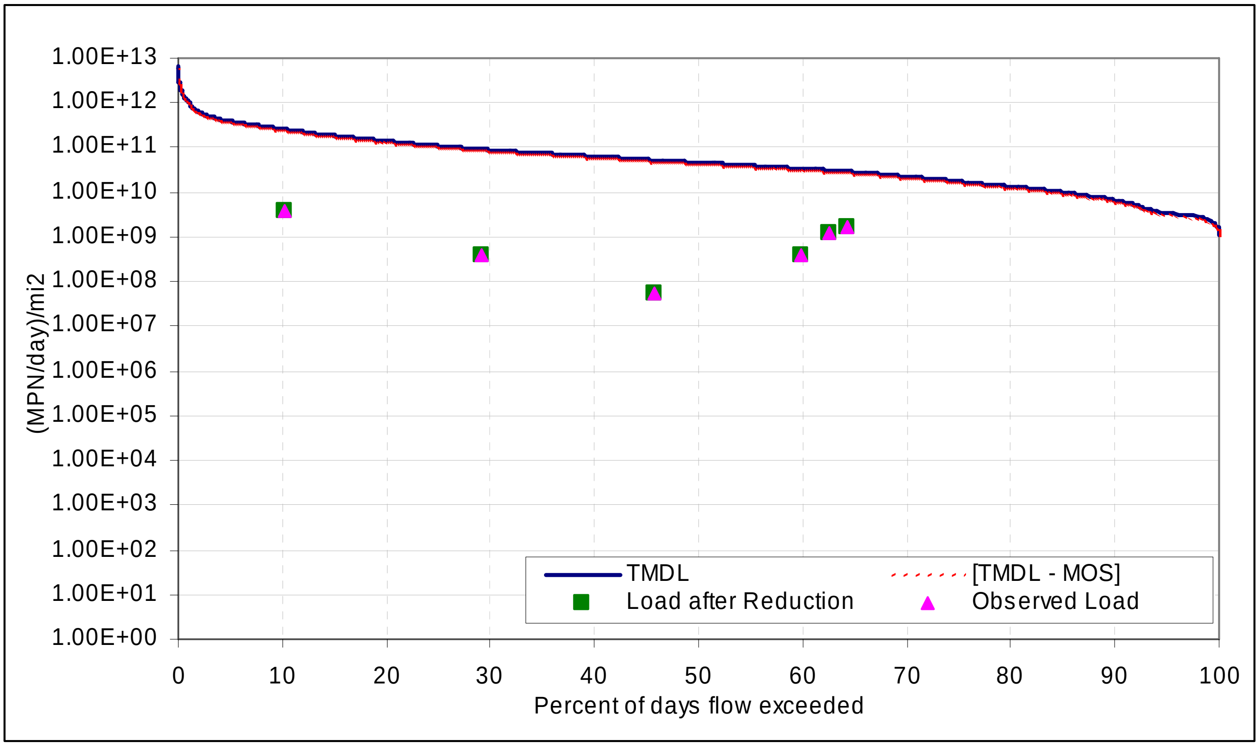

Figure D-5. Winter fecal coliform bacteria load duration curve for Bayou Anacoco (subsegment 110504) at Standard, Louisiana (station 1165).